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SAM Constitution

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Sacred or Scared?

IT TOOK man approximately 2,000,000 years to really begin using fire — 20,000 to begin firing-up the steam engine — 200 years more to build the modern factory — 20 years to get fission, fusion, electronics and computers — and a second industrial revolution! Thus does the rate of technological change accelerate by geometrical ratio. When a people's social progress falls behind the progress in technology, the results make history.

The European with geometry and firearms put the Indian with arithmetic and bow and arrow on the reservation. Today Indians learn geometry and calculus but too late to recapture their continent. Until the old generations died out (or were killed off) they could not master the new technologies.

In 1905 over 250,000 young Chinese took the annual examination for government positions. The exams consisted in reciting verbatim the eleven "Sacred Classics" of Chinese literature (some several thousand years old) and writing "original" poems not distinguishable in form or content from those in the classics. Thus were chosen the government executives to manage China in a twentieth century world. This "management development" plan was followed by revolution, beheadings, collapse, torture, firing squads, and "brainwashings."

Thus does history punish a social leadership when education "preserves" a culture instead of "managing" power. This mid-century is another historic testing time for social leadership of our age.

Today in America we are dedicated to freedom. Freedom means decentralization of authority so that individuals, companies, and communities can exercise initiative, make choices and be the source of their own activity. This decentralization of initiative requires decentralizing wisdom and technical know-how. Unless individuals, companies, and communities understand the modern tools and processes they are as helpless today as were the Indians who faced our ancestors with bow and arrow. They are as doomed in the days ahead as was the Chinese student of the Classics that were no longer "sacred."

Technological change can transform classics from *sacred* to *scared*. In this dynamic — nay, electronic — era our "way of life" will triumph not by being "preserved", "pickled", or "embalmed" but by being *transformed* and *grown*. This task requires initiative not just in a few centers but everywhere.

"Cultural lag" from center to border must be cut from thirty years to five. Managers who merely follow and not lead must either be "shot" or retired, or developed. The only American way is development and there is no development in the last analysis but self-development.

Every Chapter of S.A.M. must see to it that in their own communities management does not stand pat, imitate, drift, die-back, or die-off. They must be helped to manage and to advance the technology of their companies and communities.

Mr. Khrushchev is quoted as saying that communist Russia does not need war. She can win the peace, says he, by out-producing capitalism in scientists, in technology, in producers and in products.

The Society for Advancement of Management accepts Mr. Khrushchev's challenge and summons seven thousand "Paul Reveres" in sixty chapters — to spring, not to arms, but to *free* work and decentralized *leadership*.

F. F. BRADSHAW

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Fundamentals Of Measurement

By Paul Kircher
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In response to the increasing demand for business measurement systems, a great deal of work is being done on the fundamental concepts and processes of management measurement, discussed in this article. The structure of the measurement process is analyzed into its elements, with examples from such measurement systems as accounting, job evaluation, and the selection and evaluation of executives.

MEASUREMENT has always been an important factor in providing information to serve as the basis for solving business problems. But as business management has become more and more interested in using scientific tools to aid in making decisions, it has become increasingly evident that present methods of measurement in the business field frequently are inadequate.

For this reason the Management Sciences Research Project at UCLA, (sponsored by the Office of Naval Research) has undertaken a research study of the general problem of measurement.*

Preliminary analysis has shown that the fundamentals of measurement, as such, have never been clearly defined, even by scientists. Each discipline or science has developed its own techniques and methods, with few attempts at coordination with others. This is true in spite of the fact that it is difficult to evaluate the effectiveness of any system of measurement, or of any other logical activity, from criteria which are part of the system itself. If the system can be viewed from "outside," from a more fundamental point of view, it often is easier to correct mistakes and to obtain insights which lead to new and better methods.

There is a limit to this search for fundamentals, it must be admitted. One of the interesting aspects of modern mathematics is the discovery that as yet we cannot prove that the ultimate logical structure of mathematics is consistent. The most ambitious attempt to do this, by Hilbert, was shown by Godel to have the form of a proposition which could neither be proved nor disproved. It merely could be accepted, if one chose to do so.

There are many aspects of business logic which rest on indefinable terms or unprovable propositions. In the past these assumptions have been so numerous and so important that business has been characterized as an art. There have been few precepts of general significance—each problem the manager encountered was seen as being a brand new one, at least in some respects. As Vatter has said, "Business is an experiment."

Whereas we can expect that much of this "indefinability" will continue, nevertheless there are many relationships which can be measured in business. Especially in situations where methods such as linear programming have proven useful, businessmen are coming to recognize that decision-making can be moved to a higher plane. In these situations, it can be seen that when certain objectives are clearly defined, and the factors of the situation are objectively measured, then decisions are already made. Scheduling the operations becomes mechanical—it can be done on an electronic computer.

As a simple example, suppose a manager makes the decision that he will choose the course which earns the highest profit. He has three courses open to him (such as shipping routes). If he can measure the profitability of each of the three routes, then the policy decision in effect makes the operating decision.

We are still a long way from being able to put policy-making on a scientific basis. Policies are always set in an atmosphere of much uncertainty. Indeed, a major difference between the human brain and the so-called "electronic computer brain" is that the former can operate with partial information. A computer must have a complete program, or it

* This article was prepared while the author was under contract to the Office of Naval Research, Logistics Branch, and employed on the Management Sciences Research Project, University of California, Los Angeles.

will stop or give inaccurate results.

However, policy-making can be improved with experience, since certain situations do tend to repeat themselves. But lessons can be learned only if the important factors in each situation are measured, so they can be compared and correlated with the results of the decisions.

The Structure of the Measurement Process

The major effort of the present research study is directed toward the attempt to establish the basic structure of the measurement process. It is hoped that by dividing the process into important elements, each of these may be studied with more precision, and the relationships between them can be seen more clearly.

As indicated in the paper presented by the author to the 1955 national meeting of the Operations Research Society of America,[1] the following elements of the measurement process have been identified:

1. Determination of the objective of the business entity, the purpose which is to be served in a particular situation.
2. Determination of the types of factors which might serve to attain the objective.
3. Selection of the key aspects of the factors, the aspects which are to be measured.
4. Choice of (a) a measuring method, (b) a measuring unit.
5. Application of the measuring unit to the object to be measured—the central action of measurement.
6. Analysis of the measurement—relating it to other measurements (other in time or in kind).
7. Evaluating the effectiveness of the measurement by determining the extent to which it assisted in the attainment of the objective.

Each of these needs investigation and is being studied in some detail. Since it is impossible to describe all the various considerations within the scope of a single article, an attempt will be made to indicate something of the direction and purpose of the research by relating each of the above elements to a few specific problems. Examples will be given from:

(a) highly developed and effective systems, such as the measurement of length,
(b) highly developed but less effective systems, such as accounting,
(c) moderately developed systems, such as job evaluation, and
(d) areas where systems hardly exist, as yet, such as selection and evaluation of executives.

The first and most obvious step is to define the objective. Obvious as it is, however, it is not always easy to do.

Executives have struggled with the problem of objectives ever since companies grew from the single proprietor stage. Now that social consequences are a major consideration, many executives spend a great deal of their time attempting to establish policies which exhibit business statesmanship, and which will lead to stability and continuation of earnings, as well as immediate gains.

Unless these problems are solved, it is not possible to develop the objectives in terms that will be susceptible of some sort of quantification. In other words, it is necessary to set the stage for measurement.

Without a clear understanding of the purposes which a to-be-hired executive is to serve, it is difficult to establish standards by which to select him, and later, to judge his performance.

Determination of Relevant Factors

The second step is to determine which factors may be employed to attain the objective.

In physical problems this step is often clearly definable. When it is, the measurement process may become relatively easy, unless certain factors are physically inaccessible, or unless methods have not been sufficiently developed to handle the particular type of problem. For example, if the purpose is to provide a means of travel across a river at minimum cost, certain obvious alternatives are present—a bridge, a ferry, or a tunnel. (Of course, every such problem also presents an opportunity for the "genius" who can by-pass the problem, e.g., by finding a better route that does not go near the river, or by using helicopters.) Excepting the unusual solutions, the problem then becomes one of measuring the expected flow of traffic, measuring the cost of construction and operation of the various alternatives, and expressing the costs and capacities in comparable terms.

With a problem such as the selection of an executive the "factor" choice is considerably more difficult. In the first place, though the company organization chart may appear to offer a "slot" which is to be filled, it is not possible with present knowledge to describe the position in terms comparable to those which can be used to describe the quantity of traffic flow—such as the expected weights of the vehicles.

Even if it were possible to define the job narrowly, at the executive level the individual capabilities of the manager chosen will soon start reshaping the responsibilities and activities concerned.

Moreover, it is at least theoretically desirable that each vacancy should be the occasion for a re-examination of the company organization to see whether the position should be re-defined, or perhaps even eliminated. Such considerations add considerably to the difficulty of the measurement problem.

Selection of Key Aspects

Once it has been determined what the purpose is, and the objects to be measured, it is necessary to select those aspects which can and should be measured. These are the aspects which are themselves quantifiable, and are related in some way to the quantifiable aspects of the purpose or objective of the entity involved.

An example can be drawn from accounting. Various types of assets and liabilities are measured in order to obtain information concerning the revenue and expense flows, and the financial position of the firm. These are indicative of the degree of attainment of the profit-making objectives of the business.

The illustration from accounting is especially interesting since accountants have deliberately chosen to restrict their activities to those measurements which they believe can be made within a certain standard of accuracy. This means that certain other items, vital to the well-being of the firm, are resolutely omitted. For example, the company's investments in advertising its products, or in developing its executives, are not considered to be assets, but are written off in the period of expenditures, as a rule. Goodwill as such has almost disappeared from company statements.

In certain types of job evaluation, it is possible to quantify some of the key aspects. For example, a stenographer

[1] Held in Los Angeles, California, August 15-17, 1955.

should be able to take shorthand at so many words per minute and type at a given rate, in order to perform the duties of a given job. Other important attributes, however, such as the ability to get along with others, are harder to quantify.

In choosing an executive the problem is much more difficult. There is little knowledge as to the particular abilities which are required for a manager to act successfully in a specific situation. Even where certain abilities have been ascertained as desirable, it is seldom that they can be expressed in terms which are quantifiable. They are seldom established on the basis of what the man can *do*; rather they are usually expressed in terms of what he *is*—e.g., sincere, capable, loyal, patient, trained, experienced, etc. These attributes are difficult to express quantitatively, and thus are difficult to relate to later performance, however measured.

Choice of Measuring Method And Unit

The act of choosing a measuring method and a measuring unit has been given considerable attention throughout history, but so far not much of the theoretical work is helpful to businessmen. Mathematics, "the Queen of the Sciences," is a logical process whose object, in the words of Comte, is "the indirect measurement of magnitudes." and "it constantly proposes to determine certain magnitudes from others by means of the precise relations existing between them."

Most of theoretical mathematical work, however, has deliberately avoided the problems of application, especially to anything so "crass" as business problems. The essence of mathematics is deductive reasoning from explicitly stated assumptions. Only since World War II have many mathematicians discovered, much to the surprise of most of them, that business problems are difficult, challenging, and can be as intellectually interesting as the act of contemplating abstract "Number."

In recent years, however, activity in the application field has increased tremendously. In addition to increased activities in this field in many societies nationwide, three societies have been formed—"The Institute of Management Sciences," "The Operations Research Society of America," and the "Society for Industrial and Applied Mathematics," whose objectives express this interest.

Development of Scales

Perhaps the most advanced work in the field of measurement of a type useful for choosing executives has been done by the applied psychologists. In their attempts to measure such things as intelligence, men like Thurstone have had to develop scales where zero could not be fixed, nor could absolute intervals be specified. In several works Stevens has shown how various types of scales are possible depending upon the type of manipulation which can be performed on the measurements—the nominal, ordinal, interval and ratio scales.

Further developments have been hampered, however, by lack of clear-cut definitions of the relationship between the concepts we call "qualitative" and those we call "quantitative." Following the mathematicians, most writers appear to treat "quantity" as referring to an abstraction which somehow has almost a physical significance of its own.

It would appear to be more useful to firmly establish the concept that quantities are measurements of qualities. For example, the quality "length" occurs in various physical objects. By choosing some standard unit, and determining the number of repetitions of the unit in the object, the length can be expressed as a quantity. Then, following Stevens, the manipulations of arithmetic—addition, etc.—can be attempted to see what type of scale is involved.

In this process of measurement the problem for the observer is to identify certain characteristics in the object to be measured, characteristics which appear similar to those in the measuring unit, and which also have some identifiable relationship to the purpose of the measurement. These characteristics should be invariant, in the sense that they can be identified and seen to persist. Basically, of course, every object and every event in the universe is unique, and it is constantly changing through time. To find invariant characteristics, then, requires the human process of abstraction.

In measuring an executive, for example, the objective desired may be the organization of a research program. It is necessary to determine which types of ability are required for this, then to find a means of measuring these types of ability in the alternative men available. Each type of ability must be defined in such a way that it can be seen as a distinct part of a complicated personality. It must also be comparable to a part of the complicated personalities of the other candidates.

We are far behind the physical sciences in our ability to accomplish this. So far behind, in fact, that many people consider any effort in this direction to be useless. However, it does appear to offer the best hope for eventual improvement over present intuitive methods, so research in this direction probably will continue.

The importance of invariance can be seen in the difficulties which arise when the measuring unit chosen has varying characteristics. The dollar, the measuring unit of accounting, is an example. Changes in purchasing power not only create difficulties of evaluation, but can lead to serious inequities. An appreciable part of the "income" taxed by our government in recent years is really the result of the diminished value of the dollar unit.

Application of the Measuring Unit

The simplest method of measurement is to identify the unit characteristics in the object to be measured, and then merely to count the recurrences. Almost equally simple are the cases where the unit can be directly compared, as in measurement of length or weight. More advanced measurements, such as in astronomy, require the construction of chains of relationships.

Most business measurements involve quantity of performance in given time periods, since business is a dynamic process. The time factor introduces many complications.

Another major factor in business measurements is the force of custom. Even when systems are demonstrably weak, the difficulties of retraining and reeducating the users of data, to say nothing of the problem of development of a better system, frequently operate to hinder improvements.

On the other hand, custom does offer some advantages. Most businessmen are familiar with the major elements of the accounting system, and so can interpret results even when these are not as precise as one might wish.

In newer fields, such as measurement of executive abilities, there are several

systems in use. They exhibit few attributes in common. The result is that acceptance of the systems is correspondingly more difficult to achieve.

Analysis of the Measurements

The area of analysis of measurements in business has seen startling advances in recent years, and there is reason to hope that even greater improvements can be achieved. Primary interest has centered on attempts to relate various measurements into integrated systems that reflect the business operations. These attempts usually involve the construction of mathematical models of the operations.

Developments in linear programming, game theory, communication theory, etc., have shown that complicated situations can be resolved by the use of models if the relevant data can be obtained, and if the relationships are of certain types. While the use of some of these models requires advanced training in mathematics, others are simpler and yet very effective. Examples are the method for studying investment decisions (developed by Markowitz, see article by Weston and Beranek in the *Analysts Journal*, May, 1955) or for forecasting working capital needs (article by Rothschild and Kircher, *Journal of Accountancy*, September, 1955), or inventory control in production (Vazsonyi, *Management Science*, June, 1955).

One of the pioneers in the field of management improvement is General Electric. In a speech to the Controllers Institute, M. L. Hurni of General Electric's Management Consultation Services Division, gave a summary of the management problem which indicates how measurements are used and evaluated.

"The examination of an operation, or a situation within an operation, as a problem in logic consists in doing fundamental research upon the operation itself. It is not providing quick isolated solutions to current problems as they arise on the basis of readily available means.

"First, it consists of systematic examination of the environment in which the business exists for such things as the possible structure, range, and probability of specific demands upon the business, the recurrence or lack of recurrence of particular aspects of the environment, the drift in the environment from a given known position.

"Such examination includes not only a qualitative examination of characteristics of this type, but also application to them of strict methods well known in other disciplines, for the purpose of determining units of measure through which such phenomena or characteristics may be increasingly quantified or expressed in numbers.

"Second, it includes the systematic examination of the resources of the business for the purpose of determining quantitatively the identifying characteristics of such resources—for example, characteristics of performance, or probable malfunctioning, and the balances, limitations and restraints that may exist within the resources.

"Lastly, it includes the development and testing of models of action that give a description of the relation between the environment and the resources and which will define needs for performance and contribution, the information which must be communicated to make such performance or contribution possible, units of measure of the resultant performance, and the statement of possible risks that will result from a range of probable courses of action.

"In short, the purpose of the problem in logic is not the taking of specific action but the attainment of more complete understanding so that increasingly purposeful action may be taken with greater assurance."[2]

Conclusions

The material given in this article may serve to indicate that the problems of measurement in business are increasingly being investigated, and also that some progress is being achieved.

However, much more remains to be accomplished. The author would hesitate to present such limited results if it were not for the fact that this affords an opportunity to let people know of the research and to contribute criticisms and suggestions.

It does seem certain that progress in the directions indicated can be no more rapid than is permitted by our methods of measurement. This is a field in which business can carry on a great deal of basic research and discussion with some assurance that the payoff can be considerable. END

[2] M. L. Hurni, "Planning, Managing and Measuring the Business", Part 6, *Future Horizons In Business Management*, Controllership Foundation, Inc., New York City, Jan., 1955.

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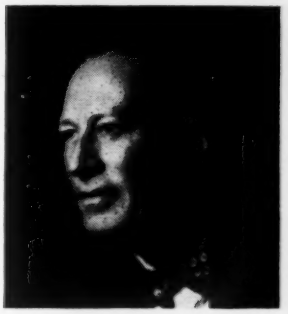

Measurement Of Management

By Phil Carroll
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"While we are developing managers we should be developing measures. We need better direction finders and instruments for flying in fog at high speeds. We should start now to build our measures of management." After considering the weaknesses in a variety of measures like "staying out of the red," sales dollar volume, and salable pieces, the author proposes the measure of "work added" or conversion cost. On this basis he advocates establishing cost and time measures of management in "getting the goods to our customers when they want them at prices they are willing to pay."

WE HAVE heard and read a lot about management development in recent years. We must admit there is ample room for development in management if my experiences in numerous discussions are representative. And surely there will be more need for skillful managers as we move further into the supersonic age ahead.

But I am wondering about the effectiveness of this current urge. How do we know whether or not these managers do develop? What measures do we have to go by? What do we expect them to do after they are developed? How do we know if they do manage better?

Did you see the terse comments related to this subject made by J. Elliott Janney before American Management Association? He reports, "Top management called in the key group of forty-two executives and laid the picture before them. After the dust settled, only six of the forty-two executives had the stomach to put a real push behind the cost reduction program without being pushed themselves. The other three dozen were full of excuses rather than constructive suggestions as to what could be done to stay out of the red.

"All forty-two had been receiving a generous executive profit sharing bonus. All had the advantages of one or more university programs in advanced management training. All had received the benefit of a wide variety of other management development schemes, yet only one seventh of them had the backbone to step up to the life-and-death job of organizational surgery."[1]

From this case, we might draw two general inferences. One is that "staying out of the red" is a rather poor measure of kind or degree of management. The other concerns the "selection" of men for development. This, by the way, is the theme of Mr. Janney's paper.

Aren't there two kinds indicated by the foregoing comments, if we can sort executives into two groups? For instance, I think of the promoter type of sales executive who may be needed to develop a new territory or "put across" a new product. In contrast, an administrative type can maintain the territory after it is opened up.

Another example is the contrast between the construction and the maintenance engineer. Are they different types of men or are their interests different?

If there is a difference, it would not affect the measurement of their skills in management. Rather, it should affect their assignments.

Coming back to "staying out of the red," I'm reminded of a comment I read recently. It was to the effect that much of our "success" results from being able to sell our products for more than enough to cover our inefficiencies.

You have seen this comment several times in a different form. It goes something like "there is as much as thirty percent wasted effort in our industrial plants."

I think G. Charter Harrison's analysis states the general condition. He says, "The outstanding defect of the conventional profit and loss statement is that it . . . reports profits *made* but it does not show profits *lost*. . ."[2]

An example of what he means occurred in a small plant. The boss man

[1] Janney, J. Elliot, "The Dollar-Getters and the Cost-Cutters," Personnel Series No. 159, American Management Association, New York, 1954.

[2] Harrison, G. Charter, "The Dead Hand of John Gough", p. 8, Madison, Wisconsin, 1941.

said, "But we made $18,000 last month." My reply was, "You mean we made $25,000 and lost $7,000."

Often, I try to make this point in another way. I recall the poster used in World War I to sell Liberty bonds. It read about like, "Are you saving any money? If you aren't all you get out of working is the exercise."

Applying this with Harrison's criticism I have found that some companies lost money on twenty percent of their volume. You know the explanation, "We must carry these items to complete our line." But it took, say, another twenty percent of profitable business to offset this loss. Thus, I conclude that all these folks got out of forty percent of their volume was "exercise."

My belief is that part of our trouble stems from using the wrong measure. I try to point out "sales dollars" is perhaps the most treacherous measure we could use of "how are we doin'."

For one thing, this measure leads some managers to strive for more volume. They seem to think that bigger sales dollars volume will cure almost any industrial illness. How can it, if they wrap up a $10 bill in each package shipped out?

I think I know what the trouble is. My analysis is that these managers latch onto sales dollars because they must have some common measure of output. In foundries, many managers measure output in tons. With mixed products, they try to get a common denominator for production. But in using either sales dollars or tons, they mix horses and apples.

Sales Dollar Volume

Salable pieces turned out are what they are trying to measure. Pieces are what the customers want. So we have to get a common denominator to measure management that allows us to correctly add together our mixtures of unlike products.

Neither labor dollars nor labor hours as used by many firms is correct enough. Standard time comes closest when our standards are set as the equivalent of good finished pieces.[3]

The point many overlook is that manufacturing is a conversion process. You might think of manufacturing as a service with material as the conveyor or the package of that service. Alexander Heron states it this way: "The employer acts as the agent for the worker in the task of selling the worker's work for the customer's dollars."[4]

CHAPTER HONOR ROLL

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SACRAMENTO	10%
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LANCASTER	5%

Conversion Cost

If you agree with that approach, we can get a basic yardstick for measuring management. The yardstick is the "work added" to borrow from the term "value added."

The difference is important. First, the wage part of "value" changes with each "revolution of the calendar." Hence, time is a better measure of work added because it is stable, up till now at least. Second, it seems easier to see our conversion costs as a rental charge for the time industry applies its skills to satisfy its customer's demands.

With such a yardstick, we can get away from distorted measures like "percents of sales dollars." Such percents move up and down with changes in material content and profit margins—plus or minus. Percents shift markedly as we decide to buy instead of make some of our components. This is a vital detail because we should not try to measure a manager's progress or lack of it with a rubber yardstick.

If we have a thirty-six inch yardstick, our next question is, "What is a manager supposed to do?" To use simple terms, he is expected to manage so that his department or his company renders a service on time at a reasonable cost through the people he supervises.

Right away we are way out on that oft-mentioned limb. We don't actually know what the service to be rendered is. We have very few time measures. And most of our costs are meaningless.

Many companies have done excellent jobs of outlining duties and responsibilities. But few departments I've seen have time schedules except payroll and billing. Few have cost controls except in the form of budgets.

Maybe I am mixed up in a chicken-egg riddle. Maybe we have to develop the managers before we can set up the measures. Maybe the newly developed managers are expected to create their own measures of their contributions. But is that the "scientific" way to go about measuring results?

It seems to me that the chief missing link is the measure of indirect or overhead work. If we had standards for overhead operations, we would have both time and cost measures. And the need becomes greater as we approach the "automatic factory" when everybody will be overhead.

With some kind of work standards for overhead operations, we would have time limits. Then the work could be scheduled to get measures of service rendered.

What Is Cost?

Also, and this is often overlooked, we could then set what the cost should be. The usual budget does not give us the cost for two reasons. First is that customarily, budgets are made up from past performances. The previous expenses may have been all right for previous mixes of products. But overhead costs may be vastly different for the current product mix. And what should they be for tomorrow's output? For instance, a company I heard about has recently added a second, quite different channel of distribution. What should be the new costs for production control, timestudy, invoicing, selling, and shipping?

Second is the budget error of "no count." How often should we do some indirect operations? Should we do them at all? The growing enormity of "clerical operations" is but one example of our failure to specify how often.

With work standards to go by, we would be on our way toward measurements of management. Starting with the goals of the company, we could work out the relations of each of its functions toward the accomplishment of these

[3] See my book, "How To Control Production Costs" if you want more explanation of this phase.

[4] Heron, Alexander R., "No Sale-No Job", p. 83, Harper & Brothers, New York, 1954.

prime and secondary objectives. Primarily, we want to get the goods to our customers when they want them at prices they are willing to pay. As Heron puts it factually, "No Sale-No Job." This may require some market research. It will take more and better forecasting than is customarily done. Surely, we will have to do some cost cutting if we are to make satisfactory profits for our efforts.

We have to begin with the customer. He supplies us with all the money. Therefore, we want to be ready and able to supply what he wants. And all the functions of the organization should be pointed in that direction. Some are directly connected like the sales people. Some are in-between like billing, credits, collection, service, shipping and often engineering. More are isolated, unfortunately, and hardly realize the need for customers. But aren't there ways to tie in everybody with some measures of service to customers?

Luxury — Optional

Certainly, everybody is a part of the cost our customers pay for—if we make a profit. So my question is not "Their ability to pay" but rather, "What is the worth to our customers of each function of our organization?"

I know that seems naive to you but I remember how Henry Ford set out to make a car "for the multitudes." Do we pile costs on costs and then pass them on to our customers? Do we just muddle along? Or do we try to find out what our costs should be if we are to perform a service customers will buy at a profit to us?

My experience is that many costs are what I call optional and luxury. We can "take 'em or leave 'em." Leaf raking—if you prefer. Besides, if you go into the costs that some managers insist are absolutely necessary, sometimes you can find unproductive and even wasted effort.

So I suggest that our second step is to weigh each cost in terms of its contribution to our customer's service. I believe that such an evaluation will call for an increase in some expenses. Production control—not stock chasing—might be one example. I'm certain that it will show the need for reduction in others.

When this is done, we would gain at least two results. One is that I think

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people in an organization would see better what their relations are to Mr. Customer. Second is that we would have more reliable measures of those we call managers.

Fast Reporting

Cost measures by themselves are not enough. We need three more conditions not usually found in industry. First is fast reporting ("feed-back"). Thirty or sixty days after the fact is much too late to plug the leak if there is any major change.

Second is reporting his expenses in understandable terms to the manager responsible for controlling that expense. Such reports are not available in many instances because accountants as such conceive their function to be that of "accounting." Their banking function is important, sure. But they have also the more vital service to perform of keeping before the managers the cost facts of an ever shifting complex of actions and interactions.

Progressive managers are always making decisions to improve their services. These change the costs. Were these decisions economically sound? Simultaneously, decisions made by other managers change the relations of any one manager's function in the whole. Where does he stand now in his costs?

Third, I want to repeat my reference to product mix touched on in connection with budgets. As customers make decisions about what and when to buy, these change the product mix. This changes the work of most overhead functions. In some, it will increase the rate of expense per unit of volume. In others, it should do just the opposite. Unless these shifts are kept before a function manager, how does he know what degree of managing he is doing? How does his superior know whether or not he is managing?

The next measures we should establish are those of time limits. I believe time measures are necessary to customer satisfaction. Does he get that spare part when he wants it? Is the machine shipped when it was promised?

Now, don't dismiss these as production problems. And don't say, "The salesman promised 'em the moon." Both statements are right, as far as they go.

What about engineering? Did they take all the delivery time in designing? What about purchasing? And methods and timestudy and tool room and credit and order writing and production control and so on?

You see, the trouble with overhead operations is that we have no time schedules because we have little knowledge either of what work is to be done or how long it should take. Consequently, many operations are put off until tomorrow. If you think I'm spoofing, try timing some indirect operation. The first all day study you take will bring in tomorrow's work. But keep at it every day and before the end of the week, you'll be studying work that belongs toward the end of the month.

That's not my point. What I'm trying to show is that there is more to being successful than having good costs. We also must be on time more often. Customers don't like to wait. Then too, they often buy on the basis of the better promise of delivery.

Two Time Measures

Hence, I think we need time measures to judge the performances of our managers. These could be of two kinds. One is the series of time measures that relate to getting work done on time.

The other is a series of measures that bring out what Fred Gardner calls "turnover" in his new book Profit Management and Control.[5] Turnover affects customer delivery promises but more so the costs of doing business. One instance is the time to process the order. This bears on our subject because managers could appear to be meeting their time schedules while doing their work sixty days late. Said the other way, we shouldn't set time schedules that assume our present time of processing is as short as it could be practically.

Now, of course, when you box in some "managers" with cost and time measures, such as I have suggested, they will get on edge. They will upset the people in their departments. That is to be expected with anything new, especially measurements.

So we are back to management development again. And I'm still wondering, "Were these managers developed?" Can they develop their successors? Do they know how to lead people to get results? What results are we talking about? Are these men good managers in that they can keep the train on the track? Can only fourteen percent (six out of forty-two) step out of routine to do some unusual but necessary task?

What About Tomorrow?

These questions bother me as I try to imagine what will happen tomorrow. According to predictions, we can expect more automation, more nuclear energy and more speed. One example of speed is Eddie Rickenbacker's prediction of 2500 mph in commercial flights. Or as one of my skilled manager friends said about operations research, "Soon we will be able to get the wrong answers so fast we will lose our shirts before we know they are gone."

On top of these complexities, some companies are adding more and more fixed costs. Our breakeven points are moving higher and higher with each "improved" mechanization and with many additions to "security."

These will be very difficult to manage especially if Peter Drucker's forecast comes about. He says that "genuine mass production . . . rests on *uniform parts* which can then be mass-assembled into a large variety of different products."[6] To me his analysis suggests that our future customers will insist upon many more individual styles. That will go against the grain of many managers who seem to want to make only one design of mouse trap.

Will we be able to develop managers capable of operating successfully in the new conditions? Can we develop them by using our own past experiences? We don't want to be like Tom in the Gilbreths' story "Belles On Their Toes." He never forgot a mistake, either, and so was able to keep making the same errors over and over again."[7]

I think that while we are developing managers we should be developing measures. We need better direction finders and instruments for flying in fog at high speeds. We should start now to build our measures of management. Otherwise we may find ourselves in the difficulties Will Rogers once described. "Yes," he said, "We used to have two-lane roads and only two cars could run into each other. Now we have six-lane highways and six cars can pile up in one accident." END

[5] Gardner, Fred V., "Profit Management and Control", McGraw-Hill, New York, 1955.

[6] Drucker, Peter, "Practice of Management", p. 100, Harper & Brothers, New York, 1954.

[7] Gilbreth, Frank B. Jr. and Carey, Ernestine Gilbreth, "Belles on Their Toes", p. 8, Thomas Y. Crowell, New York, 1950.

ROBERT L. VanDeMARK designed two economic lot-sized calculators in order to solve a business problem five years ago—and they have been put to use in one thousand companies since. He received his M. E. degree from Swarthmore College in 1942, his M. B. A. degree from the University of Michigan in 1947, and is a member of A.S.M.E. His experience has ranged from shop work through the foreman level to production manager (Robbins & Myers, Inc.), then consulting (A. T. Kearney & Co.), factory management (D. L. Auld Co.), and he is now Plant Manager of Ironrite, Inc. This article represents the culmination of about three years' work on inventory measurement.

Accurate Inventory Measurement

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An inventory system which can lead to much more accurate goals and measurement than the customary "two months' supply" is explained in this article. The author discusses the factors which influence the size of an inventory and presents the procedures for finding inventory goals in each major inventory division—purchase commitments, stores material, and in process material—which can be used by management for expense budgets or other controls.

BUSINESS inventories generally represent a large part of the total assets of any manufacturing concern. In 1950, nine percent of all business assets were in inventories. This 34 billion dollar investment not only overwhelms by sheer size, but also by cost of maintenance. Inventories require financing, storage space, personnel, and equipment for handling. They run up tax bills, and frequently depreciate in value or become too obsolete to sell. All these expenses add up to a national bill of over 500 million dollars per year. From these sample statistics it is obvious why business men consider their inventories a serious responsibility.

There is only one way in which business men can discharge this responsibility. They must maintain inventories which provide material, when needed, at the lowest possible unit cost. Having too much or too little is expensive and may be disastrous if an extreme inventory condition is reached. Extremes, such as a two-year supply for sales or an inability to meet seasonal sales demands, are obvious inventory inadequacies. Correction of such extremes requires financing and courage more than complex managerial maneuvers.

A majority of our business firms operate in the large area between the extremes. Within this area an inventory is not a factor leading to business insolvency, but rather contributes materially to the size of profit possible. In other words, for each business there are many inventory sizes which will permit operation on a profitable basis. However, for each firm there is only one size inventory (for each sales volume) which is best. The right size inventory will change with shifts in sales volume and internal operating methods. It is important then that each firm maintain a dynamic inventory policy which will keep its inventory as close to the point of maximum profitability as is possible.

Finding the inventory level which will provide maximum profitability has been left largely to estimates and a rule of thumb—the "two months' supply" multiplier. Estimates have worked for those business leaders whose intuitive business senses have grasped the basic inventory factors. The rule of "two months' supply" has worked as an industrial mean for the average firm. But how many firms are average? A very small percentage of all concerns would fall into this category. All too often multiplying a sales forecast by the multiplier of two produces an inventory goal which is inconsistent with the operating procedures of the company. *The inventory objective of any business should be based on the actual operating techniques and materials of that business only.*

For example, let us compare two companies, A and B, to show the inadequacy of this rule of the multiplier of two. Company A is a heavy goods manufacturer producing complex equipment from basic raw materials. The products of company A are many and varied, necessitating quite a stock of parts. Company B is essentially an assembly operation for which fabricated parts are purchased and standard products assembled for sales warehousing. Companies A and B are certainly quite different, but quite normal for any business community. Given the same sales volume for both companies and the facts given above, would it be logical to assume that companies A and B should carry the same size inventory?

Obviously companies A and B should have different size inventories, but that is only half the answer. The important question to answer is, "Exactly what

size inventory should each of the companies have?" The answer to such a question can only be found after an appraisal of the elements which influence the size of an inventory.

To look at an inventory as a whole would result in a hopeless muddle. Fortunately a business inventory can be split into three basic divisions:

1. Purchase Commitments.
2. Stores Material.
3. In-Process Material.

Basic Inventory Divisions

Purchase commitments are not company assets, as such, but will become assets. Commitment control assures easier inventory control because today's commitments are tomorrow's inventory. Commitments are, of course, all outstanding purchase orders for such things as direct raw materials, parts, and assemblies. Stores material consists of all direct material which is held in stores at any time: purchased material plus manufactured parts and assemblies which return to stock prior to final assembly In-process material is purchased material which is being processed and has some direct labor and burden added.

These three inventory divisions will provide the bases for establishing realistic inventory multipliers.

Regardless of the industry, product, or size of the company, there are certain basic factors which influence the size of an inventory. They are: A. Process characteristics. B. Lot-size. C. Lead time (or process time). D. Usage. E. Reserves.

A. Process Characteristics—Process characteristics are mainly concerned with the material-labor-burden relationship. Differences among products and parts dictate different values of material relative to labor and burden. Some materials require little process labor, relatively speaking, and some materials require a lot. The processing between raw material and finished product controls the amount of labor required to change the raw material into sales products.

It is easy to see that within a fixed sales volume, when the labor percentage rises, the material percentage usually decreases. As the material percentage decreases the inventory in turn may be reduced. We ordinarily refer to the relationship between final sales value and raw material requirements as the "percent of raw material in the final sales product." For example, a company putting $2.00 of purchased material into a cost of sales of $8.00 has a "25% raw material in the final sales product." Your inventory needs are strongly influenced by these process characteristics.

B. Lot-Size—Lot-size is an important factor in the size of your stores inventory. Normally a stores inventory item will show a maximum quantity consisting of a reserve plus the purchased or manufactured lot-size. The entire stores inventory will consist of a total of all the item reserves plus half of all the lot-sizes. Therefore the larger the lot-sizes, the larger the stores inventory will be. We should recognize that lot-sizes should be established on a scientific basis, but even more important, we should recognize how each lot-size affects the stores inventory.

C. Lead Time—Where lot-size is important in the stores inventory, lead time (or process time) is important in commitments and in-process inventories. Commitments and in-process material volume will vary directly with changes in lead time. Lot-sizes do not affect these inventory elements, but lead time does. At first this reasoning may not make sense, but let me explain.

Commitments are purchases in-process, so let us combine the commitments and in-process divisions and talk now solely about "in-process material." Lot-sizes do not affect in-process material because when a large lot-size is released fewer lots need to be made. When a small lot is released, additional lots will have to be released later. Therefore over a period of time the amount of material being processed will not depend upon the lot-sizes.

Lead Time Significance

Lead time, however, is important because the amount of material in process will vary directly with the length of time the material is being processed. The greater the length of time it takes to obtain purchased material or the longer it takes to get parts through the shop, the greater will be your purchase commitments or your in-process inventory.

D. Usage—Usage is a vital factor in all inventory elements. After all, future usage is the only excuse for any inventory: commitments, stores inventory, or in-process material. As your usage varies so should the size of your inventory. Therefore the effective size of an inventory depends upon the usage which is drawing upon the inventory. For example, a stores item showing 200 units on hand divided by an expected monthly usage of 80 units produces an effective inventory life of 2.5 months. In like manner dividing an entire inventory of $200,000 by an expected monthly cost of sales of $80,000 produces the same life expectancy of 2.5 months.

Calculation of Reserves

E. Reserves—Inventory reserves are similar for our purposes to a fixed asset. The amount of material which is held in reserve for possible delay in deliveries, loss, mismanagement, or other emergencies represents a fairly permanent investment. Practically every business has its "cushion" added to each stock item. There are probably as many ways to add these reserves as there are inventory systems. We can all be sure that reserves represent a management problem.

Reserves in themselves are not bad. The danger lies in careless handling of the reserve calculation or in duplication of the reserve allowances. If we leave the calculation of reserve amounts to uninformed personnel there will be mistakes. Normally we will only hear when too little is reserved, but seldom of the excess. In the end we wind up with nothing but excesses—and an excessive inventory.

Duplication can result when you have raw material, parts, and assemblies representing different stages of completion for the same stock all held as stores items. There is an opportunity to add a reserve at each of these levels. Should you fail to police this situation your reserve policy may permit reserves on all stores items and duplication will result. Reserves usually should be added at one level only. The level to choose depends upon the nature of the business. A company, or company division, mass-producing a single line of product should carry reserves at the finished part level just prior to final assembly. Reserves are needed here ahead of final assembly to assure continuous production and cost control. For a job shop the reverse is true; reserves should be maintained on raw material only. In a job shop, production is strictly to order and few accurate estimates of usage can be made beyond the raw material level. Between mass production and job shop

operations lie many compromises, each to be made on its own merits.

With the many ways in which reserves can be added it would be presumptuous to claim that any one way is best. However, to permit the presentation of a complete example, we shall use a method approved by many. Reserves will be added, at the proper level, through the addition to the minimum or reorder quantity for each stores item. Each item will have its reorder point moved ahead the number of days deemed necessary for the protection of that item. In this way our reserve for each item will consist of enough material for several days use.

There is no cut-and-dried formula for determining the size of the reserve amount. There are too many variables and unknown factors to allow the use of a simple formula. Once you have established the single level and the method of adding reserves, then you must set the actual amount for each item from experience. Supplier reliability, material availability, transportation choices, process maintenance, and weather conditions are some of the factors which you must weigh in setting reserves. A check list will help you, but depend upon knowledge of product and process for the serious task of estimating reserve quantities needed.

Inventory reserves enter into our multiplier computations for the stores division only. They always stand at the full value established—on the average. Reserves may vary with production, but you will have the total value of your reserve investment at all times.

Inventory Goals

In developing inventory goals, three general points should be made clear before we go any further.

1. We will refer to actual product and material characteristics and actual internal operating procedures to develop an inventory multiplier (similar to the rule of "2", but exact).

2. The multiplier will be developed to be used with the forecast "cost of sales" (also called "factory costs"). It is most important that we have a common base to be used with the multiplier and cost of sales provides the easiest base with which to work. To illustrate the use of these figures: If company C has an inventory multiplier of 1.74 and an anticipated average cost of sales of $8660 per month, its inventory goal would be $15,100 (1.74 x $8660).

3. When the term "inventory" is used it identifies all company assets (stores and in-process) which may eventually become direct material in cost of sales.

The basic inventory relationships have been assembled and can now be used to establish inventory goals. Our basic approach will be one of finding the figures which characterize the specific products and procedures of a business. These figures will be used to represent the actual inventory material, handled properly under existing conditions. Such summaries probably do not exist, but can be synthesized from the inventory data available on the actual material items.

We want to develop a formula for each of the three inventory divisions: Commitments, Stores, and In-Process. With these formulas we can establish multipliers for any business. For example, Company C mentioned earlier with the multiplier of 1.74 and an anticipated average cost of sales of $8660 per month might have divisional multipliers as follows.

1. Commitments—0.75 (x 8660 is $6500, contracted for)
2. Stores—1.38 (x 8660 is $12,000, on hand)
3. In-Process—0.36 (x 8660 is $3100, on hand)
4. Total Assets—1.74 (x 8660 is $15,100, on hand)

These figures are goals based on actual company products and procedures—before we finish you will see how they were obtained. Can you ask for better inventory budget goals?

The first need for our work is a sales forecast which will indicate the products for which an inventory should be provided. From the sales forecast a representative list of products is selected. Then the material list for each such product is used to classify the purchased and manufactured parts and assemblies required to make the finished products. (All items of negligible value relative to total forecast value may be discarded from the analysis without noticeable effect.) Wherever the same part or material is used in more than one product, the usage should be combined. Even where there are many products, the classification of material is not difficult.

In all cases the forecast usage is used as a weighting factor in determining the total monthly usage for each item in each classification. When the classifications have been completed, the present operating methods are investigated to determine what lot-sizes and what lead times should apply for normal operations. The unit cost of all items on the forecast is included as a weighting factor. Reserve allowances should be noted where applicable. With these figures we can proceed to the derivation and computation of the multipliers.

Multiplier Derivation

A. Commitments—Developing a commitment formula is relatively simple. The volume of commitments depends upon two basic factors: purchasing lead time and the amount of purchased material required in every dollar of production; lead time and usage, in other words. These factors have been put into a formula which will reduce the forecast data into a single figure.

To show the relative importance of each purchased item, multiply each item's lead time by its respective forecast dollar usage. Then total all the results for the total commitment requirement. To reduce the total to a true index figure, divide the total by the forecast cost of sales. The final multiplier for this division is found by Equation 1.

Equation 1. Commitments

$$\text{Multiplier} = \frac{\text{Purchased Lead Time} \times \text{Usage Dollars (each item, then total)}}{\text{Product Cost} \times \text{Number of Products (each item, then total)}}$$

$$= \frac{CE + CE + CE + \ldots\ldots C_nE_n}{PS + PS + PS + \ldots\ldots P_nS_n}$$

where C is the item lead time (months), purchased items only.
E is the item forecast usage (dollars), for the respective items.
P is the quantity of a single product in the sales forecast.
S is the factory cost (dollars) for each of the respective products.

B. Stores—In the same way the commitments are dependent upon purchase usage, the stores inventory is dependent upon the lot-sizes and reserves. The larger the lot-size and reserve, relative to usage, the larger will be the stores inventory, and vice versa. If we were to add up all the lot-size values and the reserve values for the forecast items,

that total would be the largest inventory possible. On the average, all lots will be half used up (withdrawn from stores), so we will divide the lot-size total by two to obtain the total average stores inventory.

The total figure is reduced to an index by dividing by the total forecast cost of sales. The stores multiplier is found by Equation 2.

Equation 2. Stores

$$\text{Multiplier} = \frac{\text{Lot-Size} \times \text{Unit Cost (each item, totaled)} + 2\ (\text{Usage \$} \times \text{Reserve Time})}{2 \times \text{Product Cost} \times \text{Number of Products (each item, totaled)}} = \frac{(BD + BD + BD + \ldots . B_nD_n) + 2\ (ER + ER + ER + \ldots . E_nR_n)}{2 \times (PS + PS + PS + \ldots . P_nS_n)}$$

where B is the item unit stores cost ($), including all items going through stores.
D is the item lot-size, in units equivalent to the cost units.
E, P and S are the same as in the Commitments formula.
R is the reserve inventory for safety, measured in months.

C. In-Process—An in-process inventory is somewhat more complicated than the other inventory divisions. In-process inventory is a function of the average manufacturing lead time and the value of the items being processed. The average manufacturing lead time is found by weighting each manufacturing item's forecast dollar usage by its lead time. Total the weighted results and divide by the total item dollar usages for the average lead time.

The value of the items processed consists of all the purchased material cost plus, on the average, one-half of the direct labor and burden added in processing. This value can be stated as follows: (see Equation 3, following page)

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Equation 3. In Process

Purchased Material + ½ (Cost of Sales — Purchased Material)

Using these factors, the in-process multiplier is found by Equation 3.

$$\text{Multiplier} = \frac{\text{Mfg. Lead Time} \times \text{Usage Dollars (item total)} \times \text{In-Process Value}}{\text{Mfg Usage Cost Total} \times \text{Product Cost} \times \text{Number of Products (itemized)}}$$

$$= \frac{(EC + EC + EC + \ldots E_nC_n) \times (PS + PS + PS \ldots P_nS_n + BA + BA + BA \ldots B_nA_n)}{(E + E + E + \ldots . E_n) \times 2 \times (PS + PS + PS + \ldots . P_nS_n)}$$

where E is the forecast usage ($), manufactured items only.
C is the lead time (months) for the respective manufactured items.
P and S—same as in the commitments formula.
B is the unit stores cost, purchased items only.
A is the total forecast usage (months) for the respective purchased items.

Example of Multiplier Computations

As we stated earlier, the first need is for a sales forecast. Let us take company C (referred to before) and say that all they sell are gismos (one model) and the forecast sale for gismos is about 200 per month. From this forecast we have to go to the gismo material list. It is appended to this paper for your inspection. (See Figure 1.) All the purchased materials are shown in the right hand columns. All the manufactured parts, sub-assemblies and the final assembly are shown in the left hand columns. The purchased material for the manufactured parts is shown on the same horizontal line with the manufactured part. Parts for assemblies are identified by the reference numbers in the "Used In" column.

To compile the figures needed for multiplier computation you can use either work sheets or sorting cards (one for each material item). Here we shall use a work sheet. It is shown with the material list. First the items are segregated into three groups: the manufactured parts and assemblies, the purchased material which goes through stock, and the purchased material that does not go through stock (expense material). The work sheet shows these items grouped as follows: SI—manufactured items, SC—purchased items which go through stock, C—purchased items which do not go through stock.

Beside each item is placed that item's total forecast usage, unit cost, lead time, most economical lot-size, and reserve time. With these figures we are able to complete the computations. There are seven totals from the work sheet needed in the formulas:

1. *Purchased Usage Cost* (Unit Cost × Usage). AB for purchased items only. Multiply each purchased item, SC and C, forecast usage total by its unit cost to get this cost. For this example the figure is 4756, to be found in column E, a total for all such items.
2. *Manufactured Usage Cost* (Unit Cost × Usage). AB for manufactured items only. Multiply each manufactured item, SI, forecast usage total by its unit cost to get this cost. For this example the figure is 9020, to be found in column E, a total for all such items.
3. *Purchased Material Cost* (Lead Time × Usage). CE for purchased items only. Multiply each item's lead time by its usage, using only items classified as SC and C. The total for all these results will be found in column F; for this example it is 6474.
4. *Manufactured Material Cost* (Lead Time × Usage). CE for manufactured items only, marked SI. Multiply each item's lead time by its usage. The total for this example is 4163, to be found in column F.
5. *Total Lot Cost* (Unit Cost × Lot Cost). BD for all stock items, SI and SC. Multiply each unit cost by its lot-size. Total all the results.

Figure 1. Material List and Work Sheet For Multiplier Computations.

Material List

Item No.	Used In	Part No.	Description	Quan.	Unit Cost	Lead Time	Ident. No.	Description	Quan.	Unit Cost	Lead Time
			Manufactured					Purchased			
1	Final	x100	Gismo	1	43.30						
2	1	A263	Arm Assy.	1	12.40	.25					
3	2	P196	Arm	1	1.90	.50	F196	St. Casting	1	1.35	1.0
4	2	P134	Front Plate	1	3.55	.50	F134	Al. Die Cast.	1	2.60	1.0
5	2	P288	Arm Support	2	3.70	.75	1410	St. Bar 3/4D	1.2#	.20	1.5
6	2						7515	Bearing	1	1.20	2.0
7	2						12g	Cu. Wire	.1#	.40	2.0
8	2						P165	Studs	6	.05	1.25
9	1	A247	Rotor Assy.	1	11.10	.50					
10	9	P353	Rotor	1	2.75	.25	F353	St. Casting	1	1.80	1.0
11	9	P315	Rear Plate	1	5.20	.50	F316	Al. Die Cast.	1	3.80	1.0
12	9	P112	Rotor Shaft	1	.80	.75	1410	St. Bar 3/4D	.5#	-	-
13	9						7515	Bearing	1	-	-
14	9						P168	Studs	4	.10	1.25
15	1						PA121	Elec. Motor	1	6.50	1.5
16	1						12g	Cu. Wire	.15#	-	-
17	1						18g	Cu. Wire	.12#	.40	2.0
18	1						7616	Bearing	2	1.45	2.0
19	1						P202	Pins	2	.05	1.0
20	1						P218	Bolts	4	.15	1.25
21	1						Std.	10-32-2HHBts.	20	.01	.25
22	1						Std.	10-32 Nuts	20	.005	.25

Work Sheet — Cost of Sales: 200 x 43.30 = $8660

Part No.	Class	Usage Unit	Usage Total A	Unit Cost B	Lead Time C	Lot Size D	Total Cost E	Weighted Lead Time F	Lot Cost G	Reserve Time H	Reserve Cost I
A263	SI	1	200	12.40	.25	50	2480	620	620	.3	744
P196	SI	1	200	1.90	.50	400	380	190	760		
P134	SI	1	200	3.55	.50	350	710	355	1242		
P288	SI	2	400	3.70	.75	200	1480	1110	740		
A247	SI	1	200	11.10	.50	50	2220	1110	555	.3	666
P353	SI	1	200	2.75	.25	200	550	138	550		
P315	SI	1	200	5.20	.50	300	1040	520	1560		
P112	SI	1	200	.80	.75	600	160	120	480		
				Sub-totals			9020	4163			
F196	SC	1	200	1.35	1.0	400	270	270	540		
F314	SC	1	200	2.60	1.0	1000	520	520	2600		
1410	SC	2.9#	580#	.20	1.5	2000#	116	174	400		
7515	SC	2	400	1.20	2.0	1000	480	960	1200		
12g	SC	.25#	50#	.40	2.0	100	20	40	40	.2	4
P165	SC	6	1200	.05	1.25	5000	60	75	250		
F353	SC	1	200	1.80	1.0	400	360	360	720		
F315	SC	1	200	3.80	1.0	1000	760	760	3800		
P168	SC	4	800	.10	1.25	2000	80	100	200		
PA121	SC	1	200	6.50	1.5	200	1300	1950	1300	.35	455
18g	SC	.12#	24#	.40	2.0	100#	10	20	40	.2	2
7616	SC	2	400	1.45	2.0	1000	580	1060	1450	.2	116
P202	SC	2	400	.05	1.0	2000	20	20	100	.2	4
P218	SC	4	800	.15	1.25	5000	120	150	750	.2	24
10-2B	C	20	4000	.01	.25	---	40	10	---		
10-32N	C	20	4000	.005	.25	---	20	5	---		
				Sub-totals			4756	6474	19897		2015

Figure 2. Computation of Multipliers

$$\text{Commitment Multiplier} = \frac{\text{Purchased Material Cost}}{\text{Total Forecast Cost of Sales}}$$

$$= \frac{6474}{8660} = 0.75$$

$$\text{Stores Multiplier} = \frac{\text{Total Lot Cost} + 2\ (\text{Reserve Cost})}{2 \times \text{Total Forecast Cost of Sales}}$$

$$= \frac{19897 + 2(2015)}{2 \times 8660} = 1.38$$

$$\text{In-Process Multiplier} = \frac{\text{Mfg. Material Cost (Pur. Usage Cost} + \text{Total Forecast C. of S.)}}{\text{Mfg. Usage Cost} \times 2 \times \text{Total Forecast of Sales}}$$

$$= \frac{4163\ (4756 + 8660)}{9020 \times 2 \times 8660} = 0.36$$

$$\text{Total Company Assets on Hand} = \text{Stores Multiplier} + \text{In-Process Multiplier}$$

$$= 1.38 + .36 = 1.74$$

For this example the figure is 19897, in column G.

6. *Total Reserve Cost* (Unit Cost × Usage × Reserve Time). ABH for all purchased items, SC, only. Multiply each unit cost by its usage and reserve time. The total of these results, for this example in column I, is 2015.
7. *Total Forecast Cost of Sales* (Product Unit Cost × Quantity). Multiply the forecast quantity by the product unit cost for each item in the sales forecast. For this example: 200 gismos × $43.30 or $8660, to be found at the top of the work sheet.

With these figures we can now proceed with the computation of the divisional multipliers, Figure 2.

Company C could now use these multipliers with any sales forecast as long as the product mix and processing methods remained substantially unchanged. For the forecast used to establish this example the inventory budget figures would be as follows:

Commitments—0.75 x 8660 or $6500
Stores—1.38 x 8660 or $12,000
In-Process—0.36 x 8660 or $3100
Total Company Assets on Hand—1.74 x 8660 or $15,100

If the next forecast for gismos changed from the sales level of 200 per month, new inventory budget figures could be found quickly. Merely change the Cost of Sales figure to use with the multipliers and recompute.

This example illustrates how accurate inventory goals can be established. From the above figures the company C manager would be able to evaluate the adequacy of his present inventory. He would also be able to plan his operations so that the inventory would change as the goals change.

The approach that we have used can be used in any business on any materials or processing. Realistic multipliers which can be used to establish reasonable inventory goals are our primary aim. Change the name of the product used in the example to one of your products and go through the procedure outlined. Then you will see how the multipliers are built up from actual operating procedures and product characteristics—or at least from the way an inventory *should* be handled. The multipliers reflect the current operating techniques and as such should produce goals which are fair to the operating personnel. If proper use is made of the existing operating methods and materials the inventory goals can be held.

Inventory Management

There are also two important satellite benefits to be obtained. First, in classifying the material and uncovering the lot-sizes in use, ways and means of improving the present control methods can be found in many cases.

Second, should the inventory goals indicate that the present inventory is either too large or too small, the mechanism can be reversed and inventory discrepancies found with a minimum of work. When there are many different products, the products may be grouped and multipliers computed for each group. This method will tend to isolate any discrepancies in easy-to-diagnose divisions. Such usual problems as excessive lot-sizes or reserves are easily identified by this process.

When accounting records are coordinated with the inventory divisional breakdown, the actual inventory can be compared, by division and product, with all the inventory goals. Such a comparison will indicate the areas most deserving of attention. From these areas the most important items can be selected and investigated. The expected usage for each of these critical items can be compared to its inventory. This comparison will indicate a large portion of the actual items producing the inventory trouble and provide a basis for correction.

Within any company there are changes in inventory characteristics constantly taking place. However, these changes (prices, material sizes, lead times, etc.) are usually minor in nature and consequence. Such changes alter the multipliers very little. Only when a major inventory factor (a purchase schedule, the sales distribution, a product addition, or a process installation) is affected, should the multipliers be recomputed. Naturally the multiplier bases should be reviewed at least once a year to see if a major factor has been changed or added.

We have now discussed basic inventory elements and how they can be combined in an orderly fashion to provide reasonable inventory goals. Such goals can be as useful to the business manager as expense budgets or any other business control.

In using the accurate inventory measurement system do not lose sight of the underlying principles. Reasoning is always a vital factor in inventory control and no less so in the application of these new guides. The system we have developed will help managerial judgement, but not reduce its importance. END

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THE EDITOR

R. W. JOHNSON has worked in electronics engineering since he received his B.S.E.E. degree from the University of California. He has been associated with the University of California Radiation Laboratory and the Electronic Service and Engineering Company at Berkeley, the Philco Corporation in Philadelphia, the U. S. Naval Ordnance Test Station, and is presently Chief Project Engineer in the Electronics Division of the Ralph M. Parsons Company in Pasadena. He is a Senior Member of the Institute of Radio Engineers and a member of Eta Kappa Nu and associate of Sigma XI. As this article will demonstrate, he is an enthusiastic amateur radio operator. He has published many electronics articles in technical magazines.

Management Viewed By An Engineer

By R. W. Johnson
Electronics Division
Ralph M. Parsons Company
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Engineers are not "cheaper by the dozen" these days. Many companies are struggling to attract and keep good engineers. Therefore the engineers' honest opinions of the way they are managed are of great importance to management. Their reactions have a bearing on how effectively they will fit into an organization. R. W. Johnson draws on his engineering experience with a number of companies to present his judgment of significant strengths and weaknesses of management.

A FACTOR common to many papers on management is that they are written by managers. This is natural enough, since these people by virtue of their experience in management can write with authority on the subject. While these discussions have been both helpful and illuminating, the viewpoint has been almost always the same—like inspecting the Grand Canyon from the top looking down, although the view is even more interesting from the bottom looking up.

There have been very few studies of engineering management problems *as seen by the engineer who is being managed*. This paper will present some judgments of engineering management from the viewpoint of the engineer rather than the manager.

Some basic problem areas of a universal scope will be considered and some that are only typical of large organizations, or of small ones. While the discussion is heavily biased by the experience and opinions of one individual, there is little doubt the author will find solace among many who share similar tribulations.

Finally, since most management papers contain remarks indicating *management* action required to improve an imperfect situation, this paper will present a few suggestions to *engineers* as well as thoughts for managers.

The quality of management is a problem in many companies and industries. To take an example with which I am acquainted, why is the question of good management so important in the electronics business? Why cannot managers adopt the "take it or leave it" attitude of some other industries? At least part of the answers to these questions can be found in the advertisements of any electronics magazine or newspaper—good electronics engineers are hard to get and expensive to train; turnover is costly. Similar factors are present in other industries.

The electronics industry has found that mere salary is not enough, within the bounds of reason and the need to exist competitively. If salary were the only factor, we would not have so many excellent technical people in government laboratories at salaries far below the norms of industry. I know an executive who has a sign upon his wall saying, "The SOLE Purpose of Conducting a Business is to Make a Profit," and I know more executives who heartily endorse this philosophy. Yet I know very few engineers who will tell me honestly, "The *only* reason I work here is because they pay me." In these times there are many additional incentives, both for business and for engineers.

A few of the engineer incentives besides salary are professional atmosphere, future, stability, originality and type of work, kind of organization, business ethics of the company, reputation of company, expansion policy and possibility, support given to new ideas, policies of procurement, military security, travel and procedures, and an obscure factor known as "working conditions." Rare indeed is the organization that, rating low in these factors, can attract engineers through salary alone—and survive for long.

It seems appropriate to examine here some of the things that make an organization attractive to engineers, particularly from the viewpoint of an engineer, with the hope that this discussion will be read by those who are more than engineers: the managers who *can* do something about engineering environment, and particularly the good ones who *will*.

The experienced engineer, who is the most in demand today, has usually seen many organizations good, tolerable and bad; this is part of his normal experi-

ence. Therefore he is wary of organizational structures that in his background have proven to be poor, even though the basic structure may not be at fault. He looks carefully at the organization of a company he is about to join, and if he is the discerning sort he may become acutely conscious or even supercritical of some of the following:

Organization Problems

1. *Certain Executives Types.* Some top management men are either too scientific to be good business men or too prosaic to be good engineering managers. The parsimonious, infallible conservative is avoided just as much as the abulic, uninhibited liberal.

2. *Authority of Staff over Line.* Staff groups are too prevalent which are intent on establishing innumerable obstacles to be circumvented only by the most crafty engineers, determined in their effort to get the job done in spite of, rather than because of the staff. Even *indirect* authority of staff over line is likely to be avoided by many engineers.

3. *Basis of Organizational Division.* Technical or functional lines, project lines, area, or even some more radical denominator such as time, tend to make for poor organization. Many engineers beware of divisions along the time axis such as "short range" groups and "long range" groups, the former intended to put out fires and the latter to do long range planning and engineering. The vague area of overlap in time-divided organizations often starts wars or at best results in duplication. An organization divided on technical lines does not always make the best use of people who are specialists in more than one branch of the science, although this type of division is by far the most common. A project type of organization is difficult to operate in a large organization, although it is the most flexible for a small- or medium-sized company.

4. *Delegation of Authority Commensurate with Responsibility.* This is a phrase vehemently exclaimed by managers, but frequently as mere lip service. No spectacle is more pathetic than an engineer who is held responsible for a project—for meeting its deadlines, for keeping within its budget, for its technical perfection—who is thwarted by his own management in refusing him priorities or equipment, in authorizing unjustified expenditures from his budget, reversing his considered decisions, or forcing him to accept personnel misfits.

5. *Horizontal Organizations.* In this flattened kind of organization, everyone reports to the "boss," whose door is always open, but who for some strange reason is so thoroughly engulfed in the many problems of his people that he cannot solve any of them well.

6. *Stability of Organization.* A poor organizational structure, perhaps established by a nescient manager as an experiment, is like handling nitroglycerin—it must be treated very tenderly *or else.* An atmosphere of impending upheaval—it is sometimes perpetual upheaval—can never bring out latent engineering talent, although it can stimulate ulcers. Of course a good organization is not necessarily stable, nor a stable one good—an organization is only as good or as stable as the people in it. If the people are right, even a poor organization can succeed; if the people are wrong, the best organization can fail.

Communication Problems

James F. Gordon, in a recent paper[1], likened the human communication problem between engineers and management to a number of transmitters and one receiver. The former must transmit on different channels to avoid interference, and the latter must tune to the correct channel. If the receiver bandwidth is insufficient for the transmission, information will be lost.

This theme can be expanded upon by drawing an analogy with an amateur radio DX (long distant station operator) contest, the ultimate in interference! When hundreds of stations on nearly the same frequency call a DX station, how is it that one of them can be selected (and one nearly always is)? In the answer to this question may be found some useful techniques for dealing with the communication problem in management. Sometimes it is the loudest signal that gets the reply; sometimes it is a station the DX operator knows well through past contacts; frequently it is a matter of timing, when the call is made just as the bedlam subsides; occasionally it is the longest caller; often a careful choice of frequency is the key; and rather infrequently it is the broad, raucous signal. Contest statistics show, however, that it is inevitably the most *skillful* operator who gets the most replies—the chap who can combine any number of techniques in an instant to fit the particular situation, according to his analysis of the DX operator's habits and desires. The power, signal, equipment and location all help, but the *skill* is all-important.

Empathy Required

Thus the communication "barrier" often believed to exist between nontechnical management and subordinate engineers is really no barrier at all—it is a matter of language, of expression, of empathy,[2] and of skill in timing, "power gain," "length of call," "frequency" and "signal."

Engineers who possess the capacity to think like managers and appreciate executive problems, moods, and opinions will rarely experience great frustration in communicating their ideas to the top, nor in understanding the directions they receive. In short, even if the receiver is off tune and responds only to a special code, an adroit analysis of its characteristics by clever testing methods will reveal the frequency and code to be used. Of course, if the receiver has some burned out tubes or transformers, the problem is nearly insoluble.

It can be categorically stated that all management problems result from the actions of people. So one of the most important factors in any engineer's evaluation of a company or group is the quality of the people in it. A tragically frequent error is a management decision to hire indiscriminately in the mistaken belief that through this process an emergency situation will be resolved—but actually a host of problems results.

In electronics engineering just as in every other field, there are the "floaters" and the deadwood—misfits who have not yet found their niche in life and who probably didn't belong in engineering in the first place. These unhappy people are able to survive only by coasting alone on the momentum of their "experience" until they are discovered, usually by defaulting important assignments, at which time they drift to an-

[1] *Gordon, James F., "Empathy and Its Relation to Apathy in Engineering Performance," presented Seventh Region I.R.E. Technical Conference, Phoenix, Arizona, April 27, 1955.*

[2] *An excellent discussion of this term was given by James F. Gordon in the paper previously cited.*

other job to repeat the process. Into this category fall the incompetents, the sandpaper personalities, the asthenics, the immature, the invertebrate, the indolent, the insurrectionaries and recalcitrants, and a host of other types.

Effect Of Misfits

With skillful management, misfits can be used and used profitably. Their assignments must be carefully tailored to fit them, which in turn means that they must be correctly analyzed. Managers are usually either too busy to do this, or unwilling to take the trouble. The result is that after these people are added to the payroll, an unholy mixture of wheat and chaff, of flour and sand, is strewn throughout the organization, morally depreciating the good talent that may exist. In highly competitive situations this inefficiency does not last for long—either the manager does something about it or his company slides into oblivion. It is deplorable but true, however, that in certain situations, such as with a preponderance of government work under cost plus contracts, a company can survive and even profit through inefficiency.

The solution to these problems is obvious, and again it is a matter of people. The most competent managers screen their people carefully *before* they are hired, and *screening remains a continuing process.* These managers do not grasp desperately at bodies in order to meet an unreasonable commitment which should not have been made in the first place. They plan their hiring programs according to a well-considered policy designed to get only the best people obtainable. This process is regenerative; good people attract good people, and a high professional standard with an atmosphere of minimum discord, empire building, and incompetence is a powerful attraction to competent engineers.

Early in its existence, any company should establish for itself a long range plan. As to the policy with respect to new business, particular thought should be given to government vs. commercial business, and a firm decision made on the proportions of each to be set as a goal. Thus, in the electronics industry, it is truly unfortunate that a high percentage of the total national business volume, and an even higher percentage of the *most interesting* work, is supported by the government. We say unfortunate because it is a natural tendency for an electronics firm, regardless of size, to solicit government business to the exclusion of commercial possibilities. The result is that many electronics firms are top-heavy with government work, and have no commercial outlet for their talents in the event of reductions in government spending. They have boom-and-bust cycles synchronous with Congressional appropriations, and their employees have no genuine sense of security.

Often the predominance of government business is a matter of necessity, as many firms cannot be competitive in commercial enterprise—either through too high a salary structure, too much inefficiency, too many incompetents, or insufficient capital. Again, this weakness can be laid at the feet of management —they choose the easy way of government contracts instead of putting their house in order.

Project Balance

So again from an engineer's viewpoint, let it be stated that a reasonable balance between civilian and military electronics work is an important factor in good management. Company-sponsored projects, financed with company capital rather than through devious overhead routes, are to be encouraged. These projects can be of a longrange nature until they progress to a predetermined point of completion, and the expenditure rate need not be high. Such work, whether basic or developmental, can lead to fortunes for its supporters, satisfaction for the engineers, and stability of employment. A secondary though important result is that a reasonable reserve of manpower is available to handle special contractual assignments, without the necessity for an expansion program with each new contract, or for disastrous overload of existing personnel.

"What does the future hold in store for me here?" is a question asked often by engineers, and indeed by everyone, when seeking a new position. Some people, of course, care little about the long range prospects of their employment, since they may be interested in working for others or for a specific firm for only a specified period; or for various other reasons. But most engineers have at least some calculated plan for their existence through a longer period than, say, one or two years, particularly if they are responsible people. So the question of a company's future is an important one in the minds of many engineers. It is a factor management should consider more carefully from the long range view than is now apparent.

The Company's Future

Typical factors indicative of the future company possibilities are: expansion policy of the company, capital backing of the company, foresight of management, competence of sales force, ethics of business practices, goodwill, patent position, past performance record, and potential customers. Many of these factors depend on the economy, and are best evaluated by comparison with other successful companies rather than by arbitrary standards. Further mention will be made of certain of these factors.

Expansion policy sometimes does not exist. I have known electronics firms, both successful and otherwise, which have operated on a day-to-day basis with no thought whatever to what the future holds in store, and without long range plans of any form. Sometimes almost by sheer accident a product is successful, and the firm is catapulted into an expansion program, unanticipated by its management. In other cases, a successful selling job results in a large contract or group of contracts requiring expansion of the company. *When the resulting expansion is in the nature of a step-function, watch out for transient oscillations.*

Just as the military has well-considered plans for their expansion in the event of an emergency, on a less grandiose scale all companies, but especially small companies, need plans for their future expansion. A planned teamwork effort by the engineers of the company, the advertising and sales people, staff personnel people, and particularly—emphatically—by the company management in screening applicants is essential to any expansion.

Plans should include ways to utilize to maximum effectiveness the talents of each experience level, as it is insensate to suppose that exactly those people with the proper qualifications will be found outside the company. For example, what jobs can be done by draftsmen or technicians instead of engineers?

Can junior engineers be used just as effectively as senior people if the job is partitioned into smaller segments? What sort of supervision is required, and of what sized groups? What is the most effective advertising medium? What are considered to be ethical recruitment practices? What emphasis should be given to personal contacts by engineers already with the firm as compared to advertising? What sort of budget does an expansion program require? How must supporting groups—accounting, procurement, personnel, clerical, shops, guards or janitors—be expanded relatively? How much plant and equipment is needed for each engineer? These are just a few of the many questions that, under an intelligent expansion policy, will have been considered well in advance of company growth. Only with a sound expansion policy can the organization hope to remain stable under the shock excitation of a rapid expansion.

Needless to say, adequate capital is most important. I know engineers who have obtained Dun and Bradstreet reports on a firm they expected to join, to insure that adequate capital exists. The small firm is at a definite disadvantage in this regard, but the potential may be considerable. The giants all started as small companies at one time in history, so being small is not a condemnable fault. But without capital or the means for producing it through borrowing power, it is difficult to offer stability of employment to engineers. Top management skill in *business* often transcends technical ability for this one reason alone.

Engineers Aid Sales

Relations between sales forces and engineers, and especially between sales people and potential customers, are important problems of management. If one is selling television sets to the public, a vastly different sales approach and type of salesman is needed than for selling research and development work to the military. A common fallacy of management is to believe that a glib and glittering sales department, amply supplied with brochures and expense accounts, is all that is needed to attract research and development work from any source. Contacts by competent engineers of the company directly with engineers of the customer are often discouraged in the misguided belief that engineers cannot sell. Many engineers in government laboratories will freely admit that they will go to nearly any extreme to rid themselves of a loquacious "technical representative," but are delighted to meet with an active, competent engineer from that same company, who can discuss their problems in detailed, technical terms.

Ethics of business practices have an important bearing on the future of any company. Particularly in government work, where auditors maintain a watchful eye on a company's expenditures, company management too often considers it a challenge to see how cleverly the books can be rigged to disguise unallowable expenditures. Dishonesty in any form on the part of company management can have disastrous effects upon the entire organization. After all, if the boss covers up the facts, why work so hard to meet the specifications, when the product probably won't be tested by the customer anyway?

Working Conditions

The rather broad term "working conditions" covers many things which have been discussed and debated in both engineering and management circles. For many engineers, these factors are the most important with communication, organization, people and future being of secondary interest. Many items grouped into this category can be easily listed:

Working hours
Timekeeping methods
Time-off policy
Vacations
Sick Leave
Overtime policy
Coffee breaks
Insurance programs
Recreation
Parking
Welfare funds
Advancement training
Promotion policy
Seminars
VIP or visitor handling
Crash program frequency
Office facilities
Laboratory facilities
Equipment
Conference room facilities
Library facilities
Noise
Reporting procedures
Specification methods
Procurement policy
Travel policy
Security policy
(military and industrial)
Convention and meeting policy
Regulations and directives
Professional atmosphere
Utilization of technicians
Model shop facilities

While this list by no means represents all of the items that might be termed "working conditions," it does include a number of factors of considerable interest to engineers of all levels. For this reason, this list should be of interest to management if they are concerned about attracting the best in engineering talent for the least money.

Engineers are individualists by their very nature, and rebel against regimentation. If they desire professional integrity, they will not be rigidly bound by time clocks or other restrictions essential to more routine workers or to the trades. If they are truly professional men, they have no objection to working long extra hours without compensation, if this effort is needed in special situations and is not a habitual practice. They mind neither the discomforts and long hours of travel on company business, nor the sleepless nights on airplanes nor travel on their weekends. *Conversely, however, they expect freedom and a liberal attitude in time off for their personal affairs without charge to their leave*—time for business which could have been conducted on their own time if they had not spent it working extra hours or traveling.

Outside Technical Contacts

Engineers do their most efficient work in a calm environment—well equipped with adequate space and test equipment, a quiet enclosure without distraction by the clatter of typewriters, the jangle of telephones, or the buzz of daily business. The cost of adequate working space for engineers will be returned many fold in the increased efficiency and quality of their output.

Engineers suffer from obsolescence, just as machinery; but with machinery, obsolescence is easier to correct. One cannot write a purchase order for knowledge, and the company with stagnating engineers cannot really prosper. The rapid advancements in the elec-

tronics and other fields in these times—in transistors, in microwaves, in missile systems, in computers, in components and many other areas—make it mandatory that engineers keep up in their field, with at least a working knowledge of new developments. Even then, by the time new developments are published, they are often obsolete, even if the engineer has had time to read about them.

More information can be assimilated in a shorter space of time through personal contacts and technical presentations at meetings and conventions than in any other way. Furthermore, from engineer-to-engineer contacts at such meetings comes priceless goodwill for the company—the customer learns about the company capabilities, talents, and accomplishments, and the engineer learns about the customer's problems as potential business for his firm. Many thousands of dollars spent on advertising or salesmen's expense accounts can yield not one fraction as much in results as one visit to a professional meeting by a few well-chosen engineers of the company. Attendance at technical meetings and conventions, therefore, has two fold benefits: it increases the knowledge of the engineers, enabling them to solve problems at less cost and therefore at more profit; and it creates goodwill and potential business for the company.

Procurement and Security

Procurement and security are perhaps the two areas presenting the most annoying obstacles to an engineer in his struggle to perform. It is possible to have streamlined, efficient procurement procedures and still live with Armed Services Procurement Regulations. By the simple process of delegation of requisition authority to the working level, set at some reasonable dollar limitation consistent with the job the engineer is asked to do, a great many resistors can be removed from the network between engineer and purchasing agent. An alert purchasing group, imbued with the philosophy that their job is to *help* the engineer rather than *regulate* him, can work wonders in unsnarling an impossible procurement situation. Purchasing people too often look at the dollar sign as all important, in spite of the fact that this is perhaps the least significant yardstick in measuring electronic material. Management makes a common mistake in attempting to divorce engineering judgment from procurement activity—a substantial percentage of unusable material lying idle in stockrooms or sold as surplus at a loss is the result of over-zealous and precipitious action by non-technical purchasing people acting independently of engineering recommendations.

Military security procedures and problems have been aired so often it is redundant to discuss them here, other than to observe that the taxpayers—you and I—are paying fortunes in needless duplication and inefficiency of security procedures. Industry spends almost an equal amount in trying to find ways to live with cumbersome security regulations and still accomplish its work.

Why is it, for example, that when a cleared person changes jobs, his clearance investigation must begin all over again? Why is it that official visit clearances never seem to get to the right man, so that frantic telephone calls or delays in expensive travel schedules must result? Why do classified reports take so interminably long to arrive? Why should we not have a national directory of *individuals* to which clearance requests can be addressed, and standardized, service-wide, efficient procedures for processing these requests? Why cannot the procedures be improved and expanded upon to speed dissemination of necessary information? Why are there different sets of plant security regulations for the various services, when there is supposed to be unification?

These are questions about security even management asks and should continue to ask more emphatically.

The Engineer's Duty

So far, the emphasis here has been on problems that beset engineers in their relations with management. Little has been said of the engineer's responsibility in *helping* management. Too many electronics and other engineers, smugly aware of the current supply-demand ratio, take an independent attitude and refuse to compromise their differences or do their best work. The following points should be carefully considered by all engineers:

1. There is no positive assurance that demand for engineers will always exceed supply, despite predictions to this effect.
2. When reductions in force occur, the dissident nonconformists will be the first to go, particularly if they are overpaid.
3. Good management rewards loyalty, outstanding performance, and congeniality.
4. A prime concern of an engineer is perpetuation of the species—this he can do by placing the company's best interests above his own, by selling his company and its products at every opportunity, and by loyalty. If he has no faith in his company's ability, he does not belong there.
5. An engineer has an important moral obligation: to carry out each assignment to the best of his ability, with a minimum of lost motion and inefficiency. Just as many electronic system faults are to be found in the system components, many problems blamed on management result from the engineers themselves.
6. Executive problems are at times infinitely more difficult than the most challenging technical problem. In technical areas, problems can be reduced to basic physical terms and mathematical principles, and eventually solved. In management areas, people are involved; and people can be completely indeterminate.

Dealing With Management

7. Executive ignorance of technical matters should not be abused by distorting the truth, presenting technical things in a biased manner, or misrepresenting of facts. The tailor who sells an inferior suit under special artificial light will seldom get a repeat sale from his customer. Only veracity in our relations with management will promote trust and understanding.
8. Unreasonable demands would never be made by sincere engineers if they would but appreciate executive problems and viewpoints.

The attempt has been made to illuminate some management problem areas as seen by the engineer rather than by the manager. The most appropriate conclusion seems to be the following truism:

"The reason a dollar doesn't do as much for people these days is that people don't do as much for it." END

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Operational Techniques Of Creative Thinking

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We've heard a great deal about "brainstorming" as one of the techniques such companies as General Electric, I.B.M., and General Motors are using to develop the creative thinking of their staff. Various analytical, free association, and forced relationship techniques are described and evaluated here, such as the checklist, attribute listing, input-output, brainstorming, Gordon, and focused object techniques. Rules and suggestions are presented for group sessions employing brainstorming and the Gordon technique.

THE following discussion is based on a brainstorming session held at a New England manufacturing company last spring by our research group at the Harvard Business School. In order not to disclose the actual company, the product and circumstances have been disguised.

Chairman: "Gentlemen, today, we want to develop some new ideas to make the display of our paint line more effective at the dealer level. To solve this problem, we're going to use brainstorming, one of the operational techniques of creative thinking. Be sure to remember the two essential brainstorming rules. First, make no evaluation or criticism whatsoever. We only want ideas at this stage of the problem solving process. Second, try for unusual, even impractical ideas. By ranging far and wide, you'll be more apt to come up with a new approach. All set, let's start."

Advertising Manager: "What we need are some action display devices."

Sales Manager: "How about something that lights up—something that flashes on and off. Maybe it could go on and off when you approached it. You might even have a switch that works when someone steps on a certain floor board."

Advertising Agency Account Executive: "You could have a display in the window showing your entire line. Perhaps you could use light effectively to display the colors."

Marketing Director: "I've got an idea! Why don't you tie this in with the current do-it-yourself trend. Set up a film or slides in a machine in the window and show people the proper way to paint a house."

Advertising Manager: "Show them how to do all that kind of thing—lay bricks, paint, even how to hammer a nail properly. First show them a picture —then outline the steps—then give them an ad. You might even make them come into the store to get a brochure listing the various steps shown on the slides. That would be a good way to get them into the store—otherwise, they hardly ever come in unless they're ready to buy."

Agency Account Executive: "This do-it-yourself stuff is great! Why don't you get together with other firms in the home improvement field and sponsor do-it-yourself shows in local high school auditoriums. It's already been done in large cities, but I've never seen it done in a small town. You could show films and demonstrate techniques."

Product Designer: "On this do-it-yourself kick again. Why not put a loudspeaker outside the store with a taped instructional spiel on do-it-yourself."

Agency Account Executive: "You know, I'll bet you could make a lot of money just supplying merchants with tape machines and taped advertising messages. Remind me to try that someday."

A little later:

Advertising Manager: "Let's have a miniature display—sort of a doll house affair showing painted walls—it could revolve."

Agency Account Executive: "That's not bad, but speaking of miniatures—why don't you have some miniature paint cans made up and send them out as a promotion—they could contain a sample of your paint."

Chairman: "Back to the doll house. I just had a crazy idea—it's no good to us, but what an idea! Have a doll house in which you do-it-yourself. I mean paper the walls, paint it, install miniature plumbing—perhaps even lay miniature bricks. Some toy manufacturer should love that idea. It might even bring boys into the doll house market!"

Product Designer: "A minute ago you

were speaking of displays. Why not a display in a supermarket with a pitchman or demonstrator. People have to eat so they get to the supermarket every week or so—they hardly ever get into our dealers' stores."

Agency Account Executive: "What an idea I've got—a new advertising medium. Why shouldn't local stores or even national advertisers buy advertising space on supermarket walls? Look at all the blank space behind the meat counter that people could look at while they're waiting to be served."

Sales Manager: "You might even use the ceiling, it's blank."

Marketing Director: "Here's the craziest one yet. Let's paint our different shades on the ceilings of our dealers' stores. You might even have a novelty room upside down on the ceiling."

Chairman: "They'd certainly flock in to see that—and think of the publicity value!"

Company Creative Programs

Brainstorming, as developed by Alex F. Osborn, is just one of the operational techniques of creative thinking which business organizations are beginning to use in order to enable their employees to produce more new ideas.

The whole field of creative thinking has been drawing a great deal of attention in the last few years although its application to business problems is not exactly new: General Electric has been running a creative engineering program since 1937, and Batten, Barton, Durstine and Osborn has been using brainstorming to solve certain client problems since 1939. More recently companies such as IBM, B. F Goodrich and the AC Spark Plug Division of General Motors have started various programs designed to teach their employees to be more creative and Ethyl regularly sponsors a presentation of these techniques to its clients, by Charles Clark, one of the experts in the field. Universities too are beginning to experiment with new courses designed to teach students to utilize a more creative approach to problem solving. Professor John Arnold's creative engineering course at MIT is perhaps the best known of these, but Rutgers has a special course combining engineering and creative thinking and Columbia, Boston University, Buffalo University and a host of others offer courses in applied imagination or creative thinking.

Fundamentally, the theory of creative thinking is based on the following premises:

1. Everyone has some degree of creative ability.
2. Certain mental and social factors prevent people from fully utilizing their creative ability.
3. Through proper orientation, use of certain techniques, and through practice, these mental and social blocks can be eliminated and this innate creative capacity can be utilized to a greater extent, and perhaps the level of creative ability may even be raised somewhat by training.

Techniques and programs for stimulating creative thinking can be broken down into two types: educational and operational. Educational programs and techniques are primarily designed to make a person more aware of his creative ability, and through study of the creative process and use of certain imagination exercises, attempt to raise his level of creative ability or at least to teach him how to utilize it more effectively. A great deal has already been written on this aspect of creative thinking, therefore I am going to concentrate on the operational aspects of the subject. Operational creative thinking techniques are perceptual schemes or conference methods which an individual or group can use to produce more new ideas—faster.

Basic Operational Principles

Two of the basic principles upon which all the operational techniques of creative thinking rely are:

1. A positive attitude is established—criticism or evaluation is delayed until after the ideas have been produced. This elimination of judgment from the idea production stage is one of the strongest causes for the success these techniques have achieved. Since no evaluation is allowed, negative attitudes are eliminated and a climate is created in which the participants feel free to express ideas they might otherwise be reluctant to reveal.

2. Unusual ideas are sought by encouraging many unusual, even obviously impractical, ideas, and individuals or participants in group sessions become accustomed to breaking away from traditional approaches to their problems.

The Three Types of Operational Techniques

The operational techniques of creative thinking can be roughly broken down into three categories:

1. Analytical Techniques
2. Free Association Techniques
3. Forced Relationship Techniques

Analytical techniques provide a form in which to attack a problem. They usually also rely heavily on questioning the various elements of the object or problem under consideration. They force you to ask yourself whether this can be changed or eliminated, whether a different type of power might be used, and many similar questions. Three of the commonly used operational techniques that fit into this category are checklists, attribute listing, and the input-output technique.

Free Association techniques are designed to allow any idea that comes to mind to present itself. In these techniques the use of any evaluation whatsoever in the initial idea production stage is strongly discouraged. Included in this category are the brainstorming technique and variations such as Phillips 66 Buzz Sessions, and the Gordon Technique.

Forced Relationship techniques rely on an unnatural or unusual relationship which is forced either by mechanical means or is chosen in an arbitrary manner. Once this forced relationship is established, it is used as the starting point for a series of free associations that can produce a new idea. There are a number of different variations of this type of technique. The ones I will consider will be the listing technique, catalog technique, and the "focused object" technique.

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SOCIETY FOR ADVANCEMENT OF MANAGEMENT

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One of the simplest and most commonly used analytical techniques is the checklist. Checklists have been developed for a myriad of special uses and are often very effective when searching for the solution to a specific problem. The principal reason for their effectiveness is that if properly constructed, they recall areas for investigation that might otherwise be neglected. One of the simplest and most effective general checklists is a basic nine category list developed by Alex F. Osborn, one of creative thinking's pioneers. Here it is in its simplest form:[1]

1. Put to other uses
2. Adapt
3. Modify
4. Magnify
5. Minify
6. Substitute
7. Re-arrange
8. Reverse
9. Combine

Checklists however have two rather obvious weaknesses. First, they rely on the historical accumulation of checkpoints; thus they may exclude categories that are important to the new problem being considered. Similarly, they may include many questions that are not necessary and thus may waste the user's time.

Attribute Listing

The attribute listing technique was developed by Professor Robert Platt Crawford of the University of Nebraska. Basically, it consists of listing all the attributes or qualities of an object or problem, then systematically considering each attribute or group of attributes in turn, trying to change them in as many ways as possible. An example of a number of variations that could be developed for a common wooden lead pencil through use of this technique is given in Figure 1.

The point of the example is only to demonstrate the technique. Clearly most of the ideas are neither new nor very practical, but several of them offer interesting possibilities. Remember, just one good idea can be the basis for an entire new product line or perhaps even a whole new industry.

[1] An expanded version of this list appears on page 284 of Osborn's book *Applied Imagination*, Charles Scribner's Sons, New York, 1953.

The Input-Output Technique

The input-output technique has been used in the creative engineering program at General Electric. It is used principally in problems in which energy is involved. The following example quoted from *Imagination-Undeveloped Resource*[2] illustrates this technique very well.

"A dynamic system can be classified according to its (1) input, (2) output, and (3) limiting requirements or specifications. For example in designing a device to automatically shade a room during bright sunlight, the problem can be defined as follows:

Input—Solar energy.

Output—Making windows alternately opaque and transparent.

Specifications—Must be usable on various sized windows, must admit not more than 20 foot-candle illumination anywhere in the room, must not cost more than $100 per 40 square foot window.

"Once the definition is set up, means of bridging the gap between input and output are sought. At each step the question is asked—can this phenomenon (input) be used directly to shade the window (desired output)? Using the above example once again, we observe that solar energy is of two types, light and heat.

"Step 1: *What phenomena respond to application of Heat? Light?*—Are there vapors that cloud upon heating? Gases expand, metals expand, solids melt. Are there substances that cloud in bright light? Does light cause some materials to move or curl? Light causes photoelectric cells to produce current, chemicals to decompose, plants to grow.

"Step 2: *Can any of these phenomena be used directly to shade the window?*—Vapors that cloud on heating? Substances that cloud in bright light? Bimetals warp. Slats of a blind could warp shut.

"Step 3: *What phenomena respond to step one outputs?*—Gases expand, could operate a bellows, etc. Photoelectric current, could operate a solenoid, etc. Solids melt, effect on electric conductivity, etc.

"Step 4: *Can any of these phenomena be used directly to shade the window?*—Bellows could operate a blind, etc.

"Step 5: *What phenomena respond to step three output?*—Bellows, solenoid etc. could operate a solenoid switch or valve, which in turn could operate motors to draw the blind.

"In this manner a number of possible solutions can be developed for evaluation."

For most purposes either attribute listing or the input-output technique are probably more effective than checklists because they are based upon an individual analysis of the product or problem in question rather than on an historical accumulation of checkpoints. However the two techniques are not particularly suited to the same type of problem. Attribute listing is generally most effective when attempting to change or modify an existing object or procedure because it concentrates on the at-

Figure 1. Example of Attribute Listing

Attribute	*Possible Changes*
Lead produces writing	Light might be used to affect photographic paper. Heat might be used to affect a special paper. Could use a solution instead of solid lead or might use a chemical solution that reacted with the paper. (Some of these variations might lead to a pencil or writing instrument that never had to be sharpened or refilled.)
Wooden casing	Could be metal; plastic; entirely made of graphite.
Plain yellow color	Could be any color; carry advertising; or have a design. (Perhaps women would buy pens and pencils carrying the same designs as their dresses.)

[2] Pages 27-28, Imagination-Undeveloped Resource, Creative Training Associates, P.O. 913, Grand Central Station, New York 17, N. Y.

tributes of the object or procedure in question. The input-output technique on the other hand concentrates on the job to be done, thus it is probably best suited for seeking new or alternative ways to accomplish some objective.

Brainstorming

In our society, and throughout our educational process, hard sharp critical judgment has been held out as the mark of the capable man. The basic theory behind the brainstorming method is that many times this worship of critical judgment prevents people from expressing ideas that are a bit unorthodox. Thus, although this unorthodox idea might have been the best solution to the problem at hand, it is not revealed because its originator fears that his reputation for having good judgment may suffer. Furthermore, in many cases it is extremely easy to find fault with even the best idea. Thus in many cases when good ideas are expressed, they are quickly quashed by the exercise of judgment or criticism before they get a real chance.

In a brainstorming session, a climate that is most conducive to the production of ideas is set up. First, no judgment or evaluation is allowed at all. Secondly, the participants are encouraged to produce as many ideas as possible. They are even encouraged to express ideas that are extremely impractical. Who knows, what at first may seem to be a poor idea may stimulate someone else to produce a better idea, or this poor idea itself might even be developed into something useful. In fact, General Electric demonstrates the effectiveness of the brainstorming method by deliberately taking the idea the group members consider the poorest, and developing it into something useful. In one session held at the Harvard Business School for members of the Advanced Management Program by people from General Electric, a toaster was the subject under consideration. Of all the suggested improvements for the toaster, the one the group considered the poorest concerned making toast or toasters mouseproof. Yet, perhaps this idea is not as silly as it sounds. Conceivably, toast or all food for that matter could be treated with some chemical which is offensive to rodents and insects, yet did not affect human beings or the taste of the product. If this process could be developed, the nature of the food preservation business might be drastically changed.

In addition to providing a climate encouraging ideas and freedom of expression, brainstorming works for several other good reasons:

1. Contagion of enthusiasm.
2. Competition, everyone tries to produce more and better ideas than the other participants.
3. It provides the opportunity to improve or change the ideas of others. What may seem absurd to one person, may stimulate someone else to suggest a useful variation.

Brainstorming can also be done on an individual basis. Simply follow the rule of no evaluation and turn off the judicial side of your mind during the idea production stage. After all the ideas have been produced, they can be evaluated, preferably at a later date. This is the time for sharp judgment, after you have the ideas.

A Phillips 66 Buzz Session is often applied to brainstorming with large groups. Basically, a large group is broken down into a number of smaller brainstorming groups. Each group appoints a chairman and proceeds to brainstorm. After they have produced a number of ideas, they select one or more of the better ideas. The chairman of each small group then presents the selected ideas to the entire group.

The Gordon Technique

The Gordon technique was developed by William J. J. Gordon of Arthur D. Little, Inc., a research and consulting firm in Cambridge, Mass. This technique is the basic method used by Arthur D. Little's Design Synthesis Group. This group invents new products to order for their clients. So far they have never failed to produce a requested invention. Among the products they have invented are a revolutionary new type of gasoline pump, a new type of can opener, and a new method of building construction.

The objective of a Gordon session is different from that of a brainstorming session. In a brainstorming session, a multiplicity of ideas is sought. In the Gordon method, only one radically new idea is wanted.

The principal characteristic of the Gordon discussion session is that only one man—the group leader—knows the exact nature of the problem to be solved. There are two main reasons why Gordon feels that the other panel members should not know what the problem is. First, he feels that brainstorming produces superficial ideas because solutions are arrived at too soon. He avoids early solutions by not revealing the problem. Secondly, he seeks to avoid "egocentric involvement." In other words, a participant in a brainstorming session may become infatuated with one of his own ideas—perhaps he may even go as far as to consider it the only logical solution. Naturally, such involvement can seriously hamper the participant's effectiveness.

Since the group members do not know the problem being considered, it is extremely important to choose a suitable subject for discussion, one that is related to the actual problem, yet which does not reveal its true nature. Here are a few examples of products and the discussion subject used: toys—play or enjoyment; fishing lures—persuasion; a new can opener—opening.

Here's an example of how a session using the Gordon technique might be conducted. Suppose the problem were to invent a new type of lawnmower. For this problem the subject for discussion could either be cutting or separation. In this case, separation would probably be the best choice because it encompasses a somewhat broader area. Cutting almost implies some sort of mechanical motion employing a blade or blades.

CHAPTER MEMBERSHIP STANDINGS AS OF September 1, 1955

New York	397	Bridgeport	65
Northern N. J.	336	Knoxville	64
Philadelphia	333	Alabama	63
Cincinnati	294	Providence	63
Chicago	281	Trenton-Del. Val.	63
Cleveland	253	Columbus	62
Lancaster	249	Puerto Rico	62
Pittsburgh	230	Reading	61
Detroit	195	Hartford	57
Boston	187	Central Penna.	52
Washington	184	Calumet	51
San Francisco	156	Charlotte	49
Milwaukee	150	Clearing	48
Dallas	140	Western Mass.	46
Los Angeles	130	Central N. Y.	43
Worcester	124	Greenville	43
Indianapolis	120	St. Louis	41
Raritan Valley	103	Lehigh Valley	40
Western N. C.	102	Twin City	39
New Haven	97	Fox Valley	37
Binghamton	95	New Orleans	36
Montreal	95	Athens	34
Greensboro	90	Madison	31
Hudson Valley	90	Nashville	29
Kansas City	87	N. E. Penna.	29
Dayton	86	Portland	27
Baltimore	80	Louisville	20
Richmond	73	Stamford	17
Wilmington	68	Non-Chapter	109
Georgia	67	Non-Resident	80
Sacramento	67		

Figure 2

Summary of Rules and Suggestions for Group Sessions

Osborn Brainstorming

Rules:

1. Judicial thinking or evaluation is ruled out.
2. Free wheeling is welcomed.
3. Quantity is wanted.
4. Combinations and improvements are sought.

Suggestions for the Osborn technique:

1. Length: 40 minutes to one hour, sessions of ten to fifteen minutes can be effective if time is short.

2. Do not reveal the problem before the session. An information sheet or suggested reference material on a related subject should be used if prior knowledge of the general field is needed.

3. Problem should be clearly stated and not too broad.

4. Use a small conference table which allows people to communicate with each other easily.

5. If a product is being discussed, samples may be useful as a point of reference.

Gordon Technique

Rules:

1. Only the group leader knows the problem.
2. Free association is used.
3. Subject for discussion must be carefully chosen.

Suggestions for the Gordon technique:

1. Length of session: two to three hours are necessary.

2. Group leader must be exceptionally gifted and thoroughly trained in the use of the technique.

General Suggestions that apply to both techniques

1. Selection of personnel: a group from diverse backgrounds helps. Try to get a balance of highly active and quiet members.
2. Mixed groups of men and women are often more effective, especially for consumer problems.
3. Although physical atmosphere is not too important, a relaxed pleasant atmosphere is desirable.
4. Group size: groups of from four to twelve can be effective. We recommend six to nine.
5. Newcomers may be introduced without disturbing the group, but they must be properly briefed in the theory of creative thinking and the use of the particular technique.
6. A secretary or recording machine should be used to record the ideas produced. Otherwise they may not be remembered later. Gordon always uses a blackboard so that ideas can be visualized.
7. Hold sessions in the morning if people are going to continue to work on the same problem after the session has ended, otherwise hold them late in the afternoon. (The excitement of a session continues for several hours after it is completed, and can affect an employee's routine tasks.)
8. Usually it is advisable not to have people from widely differing ranks within the organization in the same session.

The session would probably open with a discussion of what separation means. The discussion would then probably move on to ways in which things are separated in nature, industry, or the home. A possible solution might be recognized by the group leader when someone talked about the rotary saw blade used in a sawmill to cut lumber. Perhaps a few years ago this idea might have led to the development of the rotary blade lawnmower now on the market. Next, someone might mention welding, and how a flame can be used to cut or separate a piece of metal into two pieces. Possibly this might lead to a solution in which a flame was used to singe the tops of the grass. Another and probably better variation might be a lawnmower that consisted merely of a single heated wire designed to accomplish the same thing. If such a lawnmower could be developed it might have several strong advantages: it would be light and easy to push and there would be no moving parts—thus it might be both safer and longer lasting. The sole purpose of this illustration is to show the kind of possibilities that occur to the group leader as the discussion moves along.

The sessions held at Arthur D. Little usually last three hours. This amount of time is necessary if a thorough discussion of the subject is to be held. After the initial idea is obtained, the group develops the idea into a finished, patented product by more conventional means.

Comparison of Systems

The principal weakness of the Gordon method is that so much of the success of the session depends upon the group leader. Unless he has the ability to see relationships quickly, the session can be a failure. Also, if the other members of the group had known the exact nature of the problem, they might have been able to see relationships the leader missed. Very possibly, these relationships might have led to even better solutions for the problem at hand.

Several procedures might be followed to overcome this weakness. In one case, the session would be conducted as at present and the proceedings would be tape recorded. Then, after the session was finished and the problem revealed, the other group members would listen to the recording to see whether there

were other possibilities the group leader missed. In the other alternative method, half the group members would know the problem, the other half would not. In this case, three to five people can attempt to see the relationships leading to a solution.

Our research group at Harvard felt that for most purposes, the Osborn brainstorming system is most practical. Its rules are simple and easily understood. Furthermore, many business problems especially in the advertising, sales promotion, and merchandising area call for a wide variety of ideas. The brainstorming session is especially effective in producing a large number of different ideas.

The Gordon system on the other hand probes much deeper than the Osborn system. It goes back closer to natural phenomena and is therefore especially useful for deriving entirely new principles. However, it requires an extremely capable group leader and well-trained participants. Therefore this type of session cannot usually be successfully conducted by novices, whereas brainstorming sessions very often can. A summary of rules and suggestions for both types of group sessions is given in Figure 2 reproduced from *Imagination-Undeveloped Resource.*

Forced Relationship Techniques

The forced relationship techniques are not particulary suited to solving an existing problem except in the broadest sense. This is because they rely on a chance relationship which is almost impossible to relate to the particular problem at hand. However, they are extremely useful in the artistic or literary fields where the user is often seeking only a new and different idea rather than the solution to a specific problem.

One of the forced relationship techniques consists of making a list of objects or ideas which may or may not have some relationship to each other. The list is then numbered. The next step consists of considering the first item on the list in relationship with each of the other items in order. After item number one has been considered in relationship with each item on the list, item two is treated in a similar manner. This process continues until each item on the list has been considered in relationship with every other item on it. A variation of this technique consists of considering three or more items at the same time.

Catalog Technique

One of the favorite methods some cartoonists use to obtain a new idea is to take a Sears Roebuck catalog or a telephone book or any other source containing a large variety of different objects or categories, select two or more objects at random and force a relationship between them. This relation is then used as the basis for a cartoon idea. There are a number of other fields in which this technique or variations on the same theme can be useful.

The technique which I call the "focused object" technique contains elements of both the free association and the forced relationship techniques. It is especially useful for problems such as obtaining ideas for advertising layout or copy. The principal difference between this technique and the other forced relationship techniques is that one object or idea in the relationship is not selected at random, but deliberately chosen. The other object or idea is selected arbitrarily. The attribute or qualities of this second object or idea are then used as the starting point for a series of free associations. An attempt is made to adapt the resulting stream of free associations to the chosen object or problem. In the case of advertising copy and art ideas, the deliberately selected object is usually the product which is to be advertised.

The following example (Figure 3) shows how a common lampshade was used in a forced relationship associated with an automobile. The automobile was the pre-selected object. By focusing on the attributes of the lampshade, a chain of free associations was started, which led to other ideas. The third column shows the applications of the chain of free associations to the problem of obtaining copy and layout ideas for the automobile.

Place of These Techniques In Business

If treated in their proper perspective —as aids for better utilizing native creative capacity, and possibly increasing it somewhat—use of these operational techniques of creative thinking can greatly benefit most organizations. However, they should not be regarded as a panacea—they cannot replace good judgment and hard work.

In addition to providing a greater quantity of ideas, educational and operational programs for stimulating creative thinking provide several other benefits to companies using them. First, they clearly establish the idea in the em-

Figure 3. Example of Focused Object Technique

Attribute of Lampshade	*Chain of Free Association*	*Application to Automobile*
Lampshade is shaped like a peak or volcano	Volcano Volcanic power Explosive power Peak Peak of perfection Steep hill	"Engine has explosive power." "This automobile is the peak of perfection." "It has hill climbing ability."
The lampshade has form	Racing form Horses Horsepower Winner's circle Fine horses Other fine things Morocco leather Ivory chess sets	Use a layout showing individual horses to dramatize horsepower. "This automobile is always in the winner's circle." "He likes fine horses, he likes fine cars." Associate car with fine things.
	Africa	Picture car in use in Africa and all over the world.

ployees' minds that the company wants new ideas. Secondly, through use of these techniques, employees usually become much more confident of their creative ability—this leads to increased self-confidence that can benefit the organization in many ways. By putting the spotlight on creativity, management itself becomes much more aware of the importance of new ideas and the many factors influencing creative output in an organization. Creativity is encouraged by a permissive atmosphere—that is an organizational climate in which freedom of expression, mutual trust, and respect are present. Once management clearly becomes aware of this more organizations will take steps to see that such an atmosphere exists. Furthermore, by encouraging freer expression of ideas, management may do much to break down the rigid barriers that too often exist between the various echelons in an organization. Thus, flexibility and improved communications may be another side result of the teaching and use of the art of creative thinking.

However, the teaching of creative thinking still faces the problem of gaining industrial and educational acceptance. Part of the reason why some people consider the subject of creative thinking "illegitimate" is due to the way in which it is frequently presented. It is offered as a cure-all with all the fanfare of a medicine show. Naturally, thinking people tend to distrust such proffered panaceas. The net result is that many people are suspicious of and even antagonistic toward the subject. Therefore any company that contemplates using these techniques should be prepared to deal with resistance and perhaps even open antagonism. The proper way to handle this is to move into the area of creative thinking gradually. Be sure you know what you are attempting to do and what the limitations of creative training are. The proper type of program installation is essential. Judge the amount of resistance you expect to encounter and conduct a promotional campaign to overcome it.

Once the difficulties inherent in establishing a program have been overcome, your company can join the ranks of companies such as U. S. Rubber, Carborundum, H. J. Heinz, and Dow Chemical Company, that are already benefiting from their experiences with creative training, not only through a greater number of new ideas, but also in improved employee attitudes and better communication. END

CIPM Reports . . .

British Views of American Management

IN a recent publication of the British Institute of Management, *Reporting Back*, some sixty British junior managers have recorded the impressions gained from nine months' academic study and industrial visits in the U.S.A. in 1951 and 1952 under government and CIPM auspices. Each group spent nine months here, alternating periods of instruction in standard postgraduate business subjects at the Universities of Syracuse and Cincinnati with visits to industries, associations, and unions. These visits varied in length from one day to two weeks. Between them the Britishers visited 452 firms, unions, associations, and government departments, both as groups and individually.

Here are some of the impressions of these groups of managers, all of whom came from responsible industrial or teaching positions.

In the opening chapter of *Reporting Back*, the British visitors state, "If there is one secret above all of the American achievements in productivity, then it is to be found in the attitude of American management." What is the nature of this "attitude" that appears to the Britishers to be the outstanding characteristic of American business? It is one, they say, which "seems to engender an aggressive management which believes that methodical planning, energetic training and enthusiastic work can solve any problem in business or, indeed, elsewhere."

Analyzing it further, the visiting managers deem this unique American approach to be basically attributable to four factors:

1. *The legacy of the frontier;* a spirit that has fostered a "sense of opportunity" that pervades American industrial and community life.

2. *Faith in business and the individual;* a faith reflected in the high esteem with which a businessman is regarded in the American national community.

3. *The ideal of competition;* an ideal that leads "even those companies which (are) not operating in a highly competitive market (to appear) to run their enterprises as though they were . . . (American managers) know that their firms must maintain their competitive position if they are to provide their people with a continuing career."

4. *Belief in change.* "Successful experiment," states the report, "is not allowed to crystallize into critically accepted custom, while unsuccessful experiment is taken as an occupational risk, and is set against the experience that has been gained."

Behind these general characteristics of the American economy lie many specific practices of American management. For instance, the Britishers found here "the dogmatic belief in mass 'consumer satisfaction,' with the corollaries of mass production, standardization, and simplification." They noted too the "extent to which production, price, employment, and economic existence are governed by the volume of sales," with the "resultant cost consciousness of every department and at all levels, and the widespread application of budgetary and cost control systems."

Two more observations round out the British picture of the main factors behind American management. Their praise of the "vitality of the trades unions, and the care and expenditure now being lavished on promoting good industrial and community relations," reflects the healthy strength of American unions in contrast to the politically-motivated unions of Western Europe. And finally, their note on the prevalence of the "belief in management education and training at all levels both in the universities and in industry; the close cooperation between the universities and industry; and in particular the care devoted by the universities and business schools in preparing students for business administration," points up the continuing vigor of a management which looks always to better achievements tomorrow.

END

Jane Dustan, *CIPM Editor*

The Council For International Progress in Management, formerly the National Management Council, is a non-profit, non-political organization devoted to the promotion of the practice of scientific management on the international level. It represents the organized management societies of twenty-four nations of the Free World with its office at Geneva, Switzerland. SAM is a charter member of CIPM.

New Management Writing . . .

HOW TO DEVELOP YOUR THINKING ABILITY

By Kenneth S. Keyes, Jr. Illustrated by Ted Key. Published by McGraw-Hill Company, New York. Pp. 242. $4.00.

Decisions, predictive ones, are the pulse beat of the managerial process. Sound decisions and straight thinking go together. Twisted thinking and emotional illness are fellow travelers. An emotionally disturbed person is like one who stands on his head. He sees everything wrong. Straight thinking is good medicine for emotional illness.

"Straight thinking will tend to make your foresight as good as your hindsight." If we know how and why thinking gets twisted, we can straighten it out. The author shows the reader how to do it. Hence, the vital role of a tool such as this book for a science of management.

Future generations of business decision makers particularly will be heavily indebted to the author for showing how 'extensionalisation' straightens out one's thinking. Alfred Korzybski tried it in *Science and Sanity*. The Fog Index of his chapter on 'extensionalisation,' however, was too high for almost everyone but Korzybski's brightest pupils. Keyes holds the Fog Index to a level that the mill-run reader can manage. Transformation of what is abstruse in Korzybski into a usable tool for decision making is the singular achievement of the book.

In a few words General Semantics is an 'extensional' discipline (orientation by facts) which trains how to use the nervous system efficiently.

General Semantics tells us that the world of real life is a world of non-identity. The word and the object are never the same. Every identification is in some degree a mis-evaluation. Thus, you can define a man 'intensionally' as a biped without feathers, or as a rational creature, etc. Such a definition would not tell you much about Vito[1], Vito[2]. An object is not a word. A map is not the territory it represents. A corn on the toe is not verbal. You can sleep on the object bed, but not on the noise you make when you utter the word 'bed.' Orientations go 'haywire' when we confuse the verbal level with the object level. Languages at best are only maps. This is the idea.

To 'extensionalise,' General Semantics uses 'extensional' devices, viz., (1) Indexes, (2) Dates, (3) Etc., (4) Quotes, and (5) Hyphens. These halt our trigger reactions—stop mis-evaluation. Take Hibbs, one of your workers! He hates the generalization 'boss.' By identification he hates all bosses. He may hate everyone around him—become neurotic and even psychotic. Indexing limits his hate to Boss[1], instead of all bosses. But to limit hate to Boss[1], is not enough. We want to get rid of it. We do this by the use of another index, viz., dating. Thus, Boss[1], 1945, *is not* Boss[1] 1955. 'Extensional' orientation facilitates individual adjustment.

With rare finesse, the author forms these 'extensional' devices into Six Tools For Thinking, Part II, Chs. 4-10. Ted Key's illustrations put a razor edge on each one of the six.

Tool No. 1—*So Far as I Know*—no one knows all about anything. Our knowledge is incomplete. Keep an open mind toward new evidence. Tool No. 2—*Up to a Point*—no pure white and pure black exist in the world of things. 'Either-or' habits of thinking lead to trouble. This tool insists that we look and see to find out up to what point things have the characteristics we are interested in. Tool No. 3—*To Me*—the way we feel about things depends on heredity, training, experience and personal interests. 'To Me' reminds us that no one sees things from all points of view. When you make a judgment you are talking about values inside of your own skin as much as you are talking about things outside of it.

Tool No. 4—*The WHAT Index*—Man 1, *is not* Man 2. No two things are identical in all respects. G. Santayana wrote that "the little word *is* has its tragedies; it marries and identifies different things with the greatest innocence; and yet no two are ever identical, and if therein lies the charm of the wedding them and calling them one, therein too lies the danger." Index numbers warn us that we can be misled by group words and averages.

The WHEN Index, No. 5—boss, 1945, is not boss, 1955. We live in a world of change. Facts of yesterday may be pipedreams today. The WHEN Index cautions us about time and our verbal maps—they go out of date. The last, No. 6—The WHERE Index—golf ball 1, on the green, *is not* golf ball 2, in the water. Any particular person or thing may act differently when put in new circumstances. Nothing exists in isolation. Everything is affected by surrounding conditions. This index tells us to look out for changes in behavior when man or thing, is placed in a different environment.

"Once we learn to use these six tools for thinking, we will find that we have automatically acquired a scientific attitude." (Chs. I, II, Part I, What is Straight Thinking).

Peter T. Swanish, Chairman,
Department of Management
Loyola University
Chicago

THE ART OF PROBLEM SOLVING—HOW TO IMPROVE YOUR METHODS

By Edward Hodnett, pp. 202, $3.50, Harper and Brothers, New York, October, 1955.

The thesis of this book is that common procedures, skills that can be developed like any others, underlie all problem solving. It is organized in four parts: Diagnosis, Techniques, Scientific Approach, and Art. Under these, the author discusses how to ask questions, how to get facts straight, how to find alternatives, how to estimate consequences, how to be logical, and how to find imaginative solutions.

MANAGEMENT PLANNING AND CONTROL—AN ANNOTATED BIBLIOGRAPHY

Prepared and published by Controllership Foundation, Inc., New York, pp. 176, $6.50, March, 1955.

A comprehensive bibliography of material on management planning and control, published in Australia, Canada, France, Great Britain, New Zealand, and the United States. It covers periodical articles, pamphlets, research reports and books in the areas of Organization for Management Planning and Control, Establishing the Goals of Business, Forecasting and Related Research and Analysis, Planning and Related Research and Analysis, Budgeting and Control of Assets, Expenses, Operations, and Reporting Results and Appraising Performance.

Information regarding October Chapter Activities will be sent on request.

NOVEMBER CHAPTER ACTIVITIES

CHAPTER	SUBJECT	SPEAKER	TITLE	PLACE	DATE
Alabama	Analysis of the Report of the Alabama Committee on Economic Development	Graham M. Byrum, Jr., Moderator	Avondale Mills		8
Baltimore	New Scientific Management Tools and Methods to Increase Efficiency and Earnings	Illustrated presentation by top executive and audience participation		Stafford Hotel	
Binghamton	Keeping A Balance In Living At Home and On The Job	Professor Herrold	Teacher's College, Columbia University	Arlington Hotel	9
Boston	Personal Growth in Business	F. Alexander Magoun	Consultant, Human Relations in Industry	Faculty Club, Sloan Bldg. M.I.T.	3
Bridgeport	Role of Money in Our Economy	Howard D. Crosse		The Algonquin Club	1
Chicago	The Coordinating Function of the Manager	W. N. Mitchell	Partner, T. T. Kearney & Co.	Furniture Club of America	22
	Timestudy & Line Balance on Assembly Operations	J. J. Obona	Chief Industrial Engineer, Simpson Electric	Furniture Club of America	8
	Administration of an Operations Research Program	Don Deeter	Hotpoint Company	Harding's Presidential Grill	
Clearing	Harvard Case Study Group				3
	Controllers and Cost Accountants				15
	Management Clinic (full day seminar)				16
	Harvard Case Study Group				17
Cleveland	Management Looks Ahead to Tomorrow's Cost Control Policies	Fred V. Gardner	Fred V. Gardner & Assoc., Milwaukee, Wisconsin	Lake Shore Country Club	7
Columbus	Electronics—Present and Future	Dr. C. C. Hurd	Director, Electronic Dept., I.B.M. Corp., Endicott, N. Y.	Fort Hayes Hotel, Gold Room	10
Dallas	General State of the Economic Health of the U.S.	David L. Grove	Economist, Bank of America, San Francisco		9
Greensboro	Business Initiative	Clem Johnson	President, U.S. Chamber of Commerce	Starmount Country Club	8
Greenville	Automation	C. S. Reed	Vice President, Duke Power Co.		9
Hudson Valley	How Industrial Psychology Looks at Management	Dr. Frederick J. Gaudet	Director, Stevens Institute of Technology	Hendrick Hudson Hotel	1
	Panel Discussion on Time Study Leveling	Paul C. Lawson, Chairman	F. C. Huyck and Sons	Hendrick Hudson Hotel	10
Indianapolis	Industrial Engineering Conference	Dr. Ralph M. Barnes, Chief Speaker	University of California	Marott Hotel, Mirror Room	10
Kansas City	Industrial Engineering Conference				17
Knoxville	Human Relations In Technical Time	Dwayne Orton	Editor, THINK, and Educational Consultant, I.B.M.	Holston Hills Country Club	8
Lancaster	The Role of an Industrial Designer in Corporate Planning	Robert H. Hose	Partner, Henry Dreyfuss, New York	Hotel Brunswick	15
	Economics Roundtable	Robert H. Laws, Discussion Leader	Director of Economics Program, SAM	Hotel Brunswick	2, 9
	Seminar—How to Conduct More Effective Meetings	A. Hugh Forster, Discussion Leader	Assistant to the President, Armstrong Cork Co.	Hotel Brunswick Lincoln Woods Inn	14, 21 28
	Plant Visitation	R. D. Owen, Director		Lukens Steel Co., Coatesville	15

NOVEMBER CHAPTER ACTIVITIES

CHAPTER	SUBJECT	SPEAKER	TITLE	PLACE	DATE
Milwaukee	Economies of Machine Replacement	R. R. Mac Nabb	Machinery & Allied Products Institute		10
Nashville	Product Design and Sales	Bert J. Klein	Sales Manager, Lane Table Co., Inc., Altavista, Virginia		10
New Haven	Systems and Procedures	Marc Baker	Supervisor, Forms and Procedures Control, State of Conn.	South Meriden House	17
	Roundtable—Visual Controls Systems	Florian Fox, Discussion Leader		Chamber of Commerce Board Room	15
	Roundtable—M.T.M. Application	Horace Bonfiglio and Frank Getz, discussion co-leaders		to be announced	22
New Orleans	Why Move to the Suburbs	Panel Presentation		Roosevelt Hotel	18
New York	Better Management through People	Dr. F. F. Bradshaw	President, SAM	Shelton Hotel	17
Northeastern Pennsylvania	Management's Attitude Towards Unions	Ed Flynn	Director, Industrial Relations Printing Industry of America, Washington, D. C.	Hotel Jermyn	7
Northern New Jersey	The Coming Industrial Revolution	Don Copell	Vice President, Wagner Baking Corp.	Essex House	17
	Maintenance Standards	Tom Wotton, Chairman		Essex House	3
Philadelphia	The General Effect on Other Departments of Sales Policies	Mr. Alderson	Alderson and Sessions Market Research Analysts	Poor Richard Club	1
	Plant Visitation			Philadelphia Youth Center	17
Pittsburgh	Industrial Relations All-Day Conference	Kenneth Field (general chairman)	Director, Labor Relations Coordination, U.S. Steel	Gateway Plaza	17
Portland	Student Chapter Night	Wm. Engessor, Coordinator		Public Service Building	30
Providence	Management's View of the Function of Organized Labor in our Economy	Archibald Williams	Vice President, American Hardware Corp., New Britain, Conn.	Providence Engineering Society	3
Raritan Valley	What Industry Expects of its Management Employees	Arthur F. Hartford	Employee Relations Dept. E. I. du Pont, Wilmington	Roger Smith Hotel	16
Reading	Economic Aspects of the "Guaranteed Annual Wage"	Prof. Paul Rusby and Dr. R. Laws		Iris Club	14
Richmond	Management Knowhow	Mrs. Wallace Clark	Wallace Clark Center of International Management, New York	John Marshall Hotel	22
Sacramento	Human Relations	Robert E. Murphy	President, Calif. Western Life Insurance Co.	Capitol Inn	1
Saint Louis	Communication	Frank Rodell	Vice President, Rodell Mfg. Company	Washington University	28
Trenton-Delaware Valley	So You Would Like to be a Plant Manager	Stanley P. Fisher	Executive Vice President, Stokes Molded Products, Inc.	Hotel Hildebrecht	15
Twin City	Management Appraisal & Inventory	David Babcock		Minneapolis Athletic Club	10
Washington	Management Techniques in Production and Sales Organization	R. A. Scoggins		YWCA	27
Western Massachusetts	Why Aren't Your Foremen on Incentive	MacRae H. Curtis,	Plant Manager	Ivy House	16
Western North Carolina	Electronics in the Office	Panel Discussion			16
Wilmington	Your Stake In Management	Carl Beck	President, Charles Beck Machine Corp.	Lord De La Warr Hotel	8

How YOU Can Organize A New S.A.M. Chapter

IF YOU'RE a S.A.M. member, do you have contacts in nearby cities or communities where a new Society Chapter would be welcome? Or if you do not have a S.A.M. Chapter where you live, the establishment of one is the best possible means for you and your friends to move ahead in your management knowledge and to develop your executive abilities!

The Society for Advancement of Management, your own professional partner in management, now has some sixty Senior Chapters and over eighty University Chapters located strategically throughout most sections of the United States and Canada. There will never be a better opportunity to get new S.A.M. chapters going than during the coming months of our period of expansion. We plan to build our chapter total to one hundred Senior Chapters and over a hundred University Chapters as soon as possible!

As our National President, Frank F. Bradshaw, puts it in his recent *Advanced Management* editorials, "Each chapter of S.A.M. becomes a local thought center and a local planning and educative focus for Management of the Future . . . S.A.M.'s goal is 100 local Senior Chapters studying scientific management locally, continuously synthesizing time-and-motion study, cost accounting, statistics, human relations, automation, and operations research. Only this kind of continuous local management development can guarantee the future of the American way of life, victory in 'competitive co-existence,' world progress, and possibly peace."

If you are interested in what is involved in organizing a new S.A.M. Chapter, write to our Executive Vice President, Harold R. Bixler, at the National Office, for our new folder, "Aids For Organizing Your New Chapter." This contains many informative Society materials and publications, such as a Check List For New Chapter Development, the Chapter Organization and Operations Manual, Check Points on Monthly Meeting Programs, our new Society Brochure and Application Form, the S.A.M. 1955 Annual Report, samples of various S.A.M. publications, and lists of material available. This shows you the practical way to initiate and guide new chapter formation.

Many benefits for the business, industrial and other institutions in your community can be derived from the formation and leadership of a S.A.M. chapter. Membership in the chapter stimulates both junior and senior executives with the best information and reports on what is appearing on the horizons of advanced management, develops them through activities on programs, committees, and in official positions in the Society, and gives them that healthy climate for growth as executives, in association and work with the men from many other organizations, which they could hardly achieve solely within their own companies.

Work in S.A.M. civic affairs alone provide untold opportunities for the development of executives, in bringing their professional management knowledge to bear on voluntary civic activities, and yields savings and many other concrete benefits for your communities. Recent Society work in civic affairs is given national recognition in the September *Reader's Digest* story entitled, "Hospitals Are Everybody's Business," and the September *Advanced Management* article, "Scientific Management Enters Civic Affairs."

So whether as a regular member you know all of the benefits S.A.M. has to offer and you have new chapter locations and contacts to suggest, or you feel a need for a S.A.M. chapter in your community, *write today* to Harold R. Bixler, Executive Vice President, Society for Advancement of Management, 74 Fifth Avenue, New York 11, New York, for full information and the folder, "Aids For Organizing Your New Chapter." END

S.A.M. Executive During Puerto Rico Chapter Installation Trip

During a recent visit to Puerto Rico, to participate in the installation of the Puerto Rico S.A.M. Chapter, Executive Vice President Harold R. Bixler and Dr. Lillian M. Gilbreth visited the Proctor Manufacturing Corporation on the Industrial Inspection tour sponsored by the Economic Development Administration. Members of S.A.M. Puerto Rico Chapter accompanied Mrs. Gilbreth and Mr. Bixler on the tour. (*Left to Right:* Harold R. Bixler; Philip A. Barreras, Asst. Manager, Proctor Manufacturing Corp.; Dr. Lillian M. Gilbreth; Ralph A. Bingham, Manager, Proctor Manufacturing Corp.; Harold E. Moore, President, Interamerican Enterprise and Executive Vice President, Puerto Rico Chapter; and Gerardo E. Maldonado, Industrial Representative, Economic Development Administration and Secretary-Treasurer, Puerto Rico Chapter.)

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Excellent opportunity with leading chemical company in southern New England locality. Applicants should have a mechanical and/or industrial engineering degree with at least 3 years plant engineering and maintenance experience background.

Duties of the position involve:

1. Methods improvement on equipment repair, machine shop work and major capital projects
2. Analysis and administration of departmental procedures
3. Estimating, planning, work measurement and data processing
4. Functional liaison with the Industrial Engineering Department

Substantial salary commensurate with qualifications.

Send resume to Box 413-W.

MANAGEMENT CONSULTANT

Graduate engineer for permanent position. Age 26-40. Experienced in managerial controls or industrial engineering in manufacturing.

Minimum Starting Income $11,000

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Management Consultant

A long-established firm desires two senior men of partnership caliber—one for Canadian headquarters.

Experience in the initiation of corporate objectives and organization planning desirable. We prefer a college-trained man, 35-45, with considerable experience in one or more phases of business administration. We require an executive who understands the meaning of professional poise and tact in dealing with officers of large companies. Reasonable travel.

Write us a complete story—it will be held in confidence.

BOX 414-W

POSITIONS WANTED

C.P.A.—ATTORNEY HARVARD M.B.A.

Diversified experience, taxes, accounting, internal control, insurance. Age 40. Objective: Treasurer-Controller. Box 412-W.

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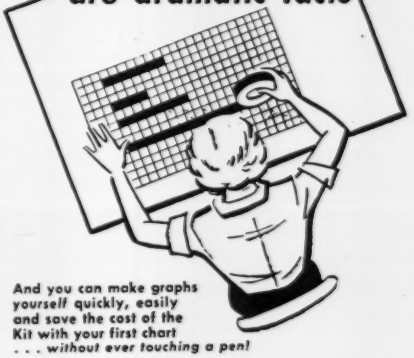

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